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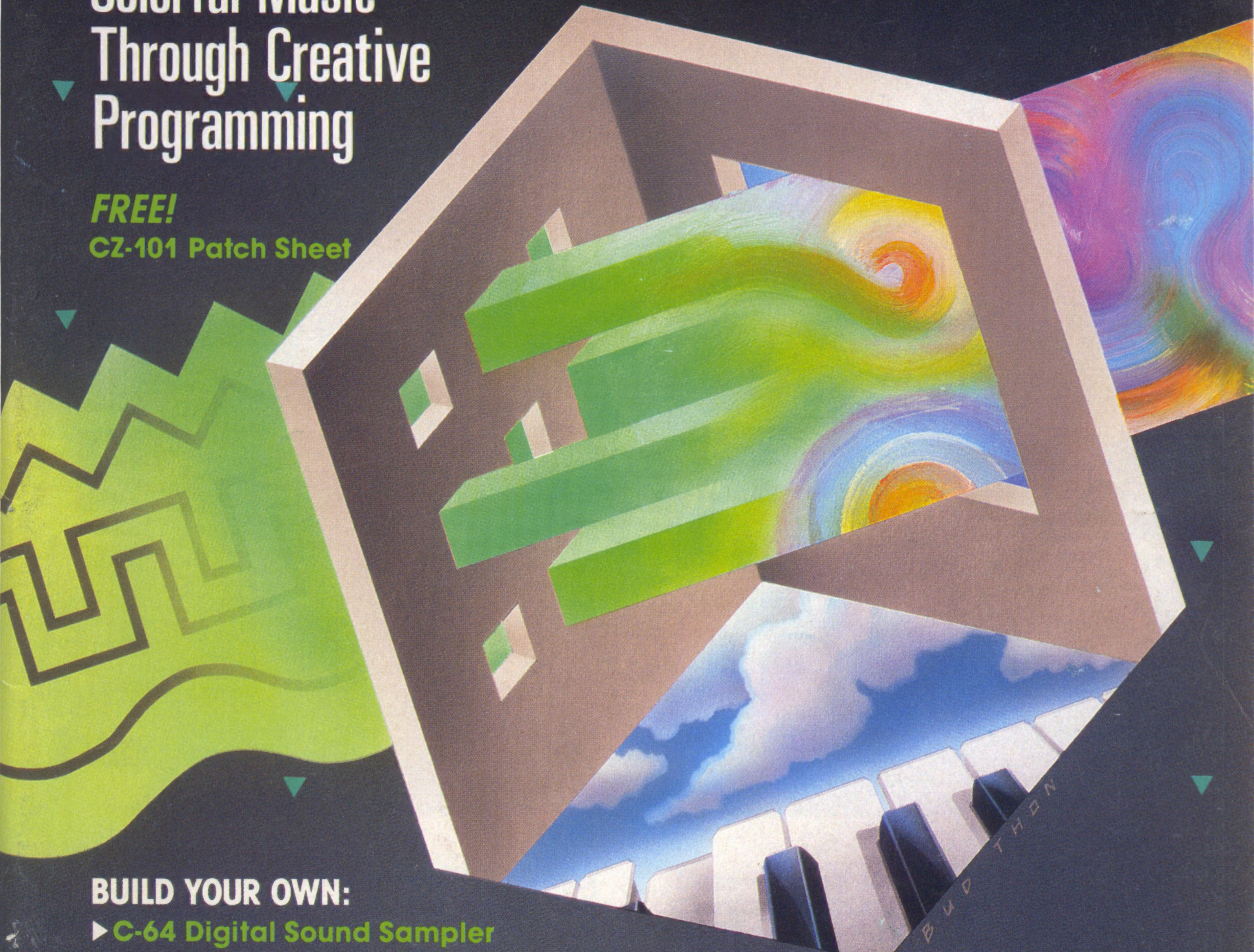

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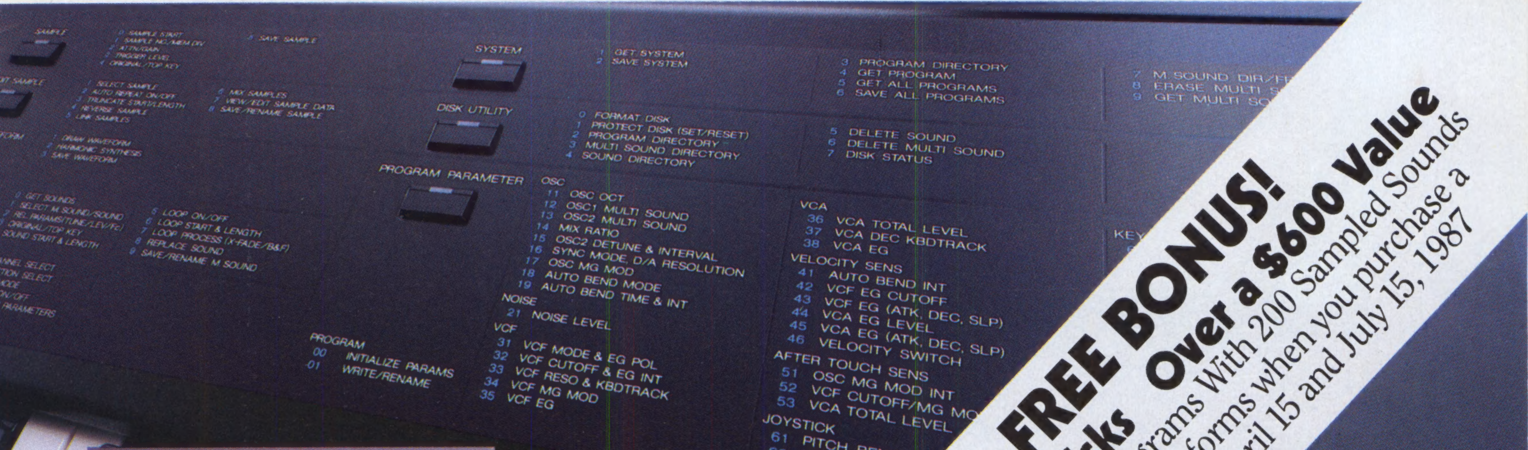
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PROGRAM PARAMETER
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13 OSC2 MULTI SOUND
14 MIX RATIO
15 OSC2 DETUNE & INTERVAL
16 SYNC MODE, D/A RESOLUTION
17 OSC MG MOD
18 AUTO BEND MODE
19 AUTO BEND TIME & INT
NOISE
21 NOISE LEVEL
VCF
31 VCF MODE & EG POL
32 VCF CUTOFF & EG INT
33 VCF RESO & KBDTRACK
34 VCF MG MOD
35 VCF EG
VCA
36 VCA TOTAL LEVEL
37 VCA DEC KBDTRACK
38 VCA EG
VELOCITY SENS
41 AUTO BEND INT
42 VCF EG CUTOFF
43 VCF EG (ATK, DEC, SLP)
44 VCA EG LEVEL
45 VCA EG (ATK, DEC, SLP)
46 VELOCITY SWITCH
AFTER TOUCH SENS
51 OSC MG MOD INT
52 VCF CUTOFF/MG MO
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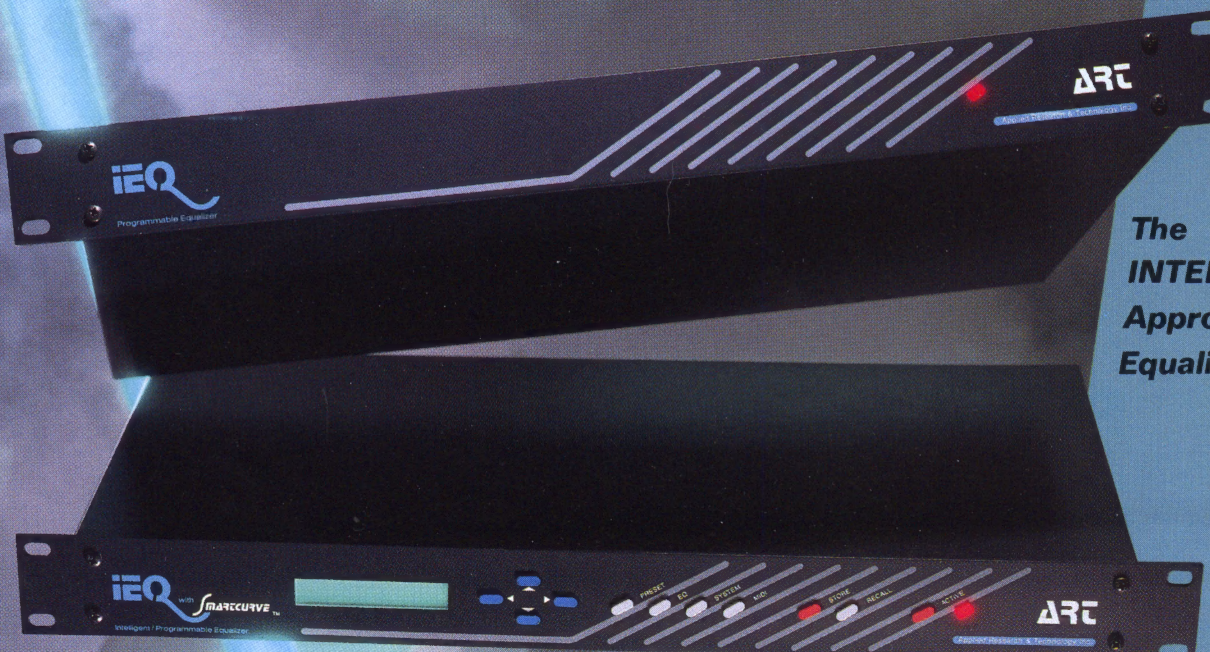
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VOL. 3, NO. 11 NOVEMBER 1987

Electronic MUSICIAN

A MIX PUBLICATION

DEPARTMENTS

6 Editor's Note
8 Letters
14 What's New
114 Advertiser Index

COVER

Patches can be dull or they can be dynamite; they can be washed-out or they can be colorful—the difference depends on your imagination and ability. This month, our cover represents how the creative process can turn an average synth sound into one of brilliance. Illustration by Bud Thon.

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ARTICLES

SYNTHESIS AND APPLICATIONS

Analog Synthesis Special by Craig Anderton
In this increasingly digital world there's still a need for the warm timbres of analog and hybrid synths. Here's how to tame these workhorses.
How Analog Synthesizers Work **50**
Shopping for a Synth: Sometimes the Little Things Count **63**
Customizing Canned Software and Factory Patches **64**

Optimizing S900 Samples Rates by David Kempton **26**
Achieve better sampling through mathematics.

Sampling Time-Varying Waveforms by Walter Daniel **32**
It is possible to meet the challenge of sampling signal-processed sounds.

The Continually Expanding Universe: Tips to Tame the DX7II by Kevin Stratton **38**
If you think the DX7II is hard to program, then you haven't read this article.

CZ-101 Patch Sheet by Craig Anderton **92**
Photocopy this page and record your patches for posterity.

TELECOMMUNICATIONS

Silicon Strollin' Through Telcom Terrain by Craig O'Donnell... **69**
Be your own bulletin board system.

Music Notation in ASCII by Leigh Ann Hussey **76**
Now you can send music notation via modem using standard ASCII characters.

DO-IT-YOURSELF

Service Clinic: Questions and Answers by Alan Gary Campbell **46**
Answers to questions about the Oberheim DX/DMX, SCI Prophet-5, Fender Chroma and Polaris.

Build SAM: A Simple Sound Sampler by Howard Cano **80**
With some hardware, some software, and a C-64 you can blow not only your mind, but EPROMs with sampled sounds.

Power to the People: Build a Bipolar Power Supply by Thomas Henry **94**
Almost every project needs a power supply, so here's one that's inexpensive, reliable, and short-circuit protected.

REVIEWS

First Take **22**
Dr. T Atari ST 4-Op Deluxe; Iota Systems Midi-Fader; Book: The Korg DSS-1 Sampler: Making It Happen; *Intelligent Music UpBeat Rhythm Programmer; Synthetic Productions "Cartridge 3" Casio RAM Cartridge with 64 Programs.*

Roland MKS-70 by Craig Anderton **101**

The Seck 1882 Mixer by Tim Tully **106**

Hill Audio Multimix by Craig Anderton **108**

Opcode MIDIMac Sequencer 2.5 by Geary Yelton **110**

Editor's Note

You just bought the synth of your dreams. It sounds great and will make a fine addition to your studio as well as your live act. Sure, it took two years to save up enough money, but you need to invest in your future, and this keyboard surely will take care of your needs for the next . . .

. . . Six weeks?!? You just found out that your machine has been replaced by something with twice the number of patches, better software, a neat-o arpeggiator, multi-timbrality, and a couple of more really nifty features. Is the manufacturer deliberately ripping you off? Is this planned obsolescence? Why, oh why, didn't you wait?

Many musicians (and computer owners) find themselves in this situation, and all too often assume this is some master plan on the part of an evil company that deliberately holds back on the goodies in order to stimulate more sales for a later model. But that's seldom the case. Manufacturers face the exact same "commit or wait" problem as we do; cheaper memory, a better microprocessor, or some other technological breakthrough is always "just around the corner." Yet the company must walk a tightrope between what's available now, their competitive position, and what the market needs. Engineers, lured by promises of technology yet to come, often have a reputation of being unable to "freeze" a design; this is usually when marketing gets into the picture, and points out that a company that doesn't ship products doesn't make money, doesn't satisfy customers, and therefore goes out of business.

How much of this obsolescence is planned? Interestingly enough, when the 1987 model synth comes out, you can bet the company is hard at work on the 1988 and 1989 models as well. Often they'll design these future projects based on certain assumptions (such as memory declining in cost enough to allow for 16-bit, instead of 8-bit, sampling). So in a sense, yes, the companies know that the 1988 model will blow the doors off the 1987 model. But there are lots of people who need to do a gig *today*, and you can't play an engineer's dream—hence the need to produce products today, using *today's* technology, for the needs of today's musicians.

You also should consider what you lose by *not* having a tool you might need. Suppose something costs you $1,300, and a year later, it costs $700. Essentially, you paid $50 a month for the privilege of having that piece of gear for a year—not a bad deal, really.

When you buy an instrument, you gamble. The people who bought a DX7, for example, watched their gamble pay off—the instrument became a huge success, lots of support programs became available, and those playing a DX7 had the latest "hot" sounds at their disposal. Those who gambled on the ARP Avatar, however, suffered a pretty ugly fate. Companies have to gamble, too; I remember the debates at one company concerning whether SMPTE or MIDI Song Pointer (neither of which were in common use at the time) would dominate the synchronization field.

Whatever piece of equipment you buy today, there will be something better tomorrow. Period. It's not a conspiracy; it's the nature of a free-market system coupled with exploding technological potential. Yes, it's painful to drop a couple grand only to helplessly stand by as a new, improved version comes out a few months later. Welcome to the world of future shock! Just remember, to paraphrase Bob Marley, that when the rain falls, it doesn't just fall on one person's house. Life in the modern world is just as tough on the people making these things as it is on the people buying them. A little more understanding on both sides (companies, how about more retrofits to older gear?) will go a long way towards helping everyone cope a little better.

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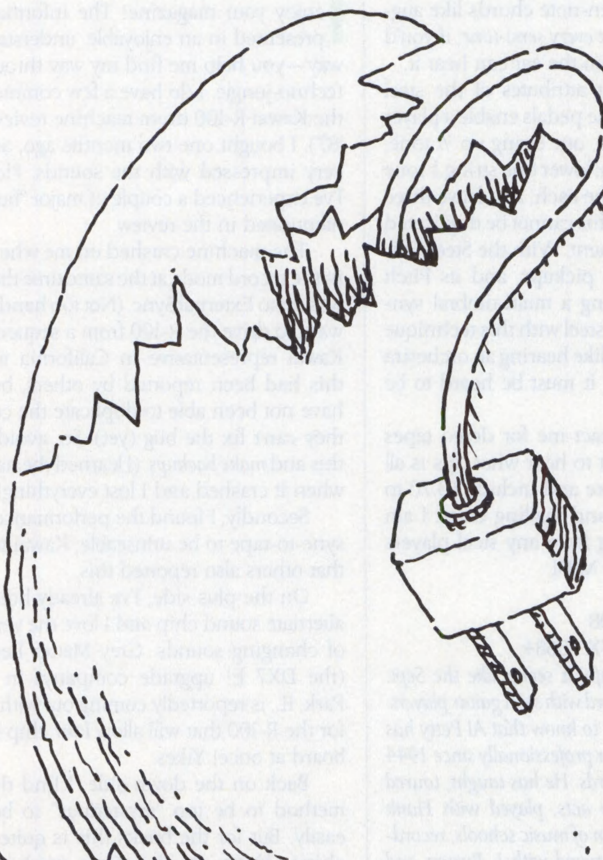

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Letters

The Original "Electronic Musicians"

I was happy to see Ned Selfe's article on the IVL SteelRider in your September issue. I have been a steel guitarist for 43 years now, and I'm thankful to be part of this instrument's entry into the MIDI Age.

Contrary to popular belief, the keyboardist was not the first electronic musician. The Hammond Tone-Wheel and Wurlitzer Reed organs of the mid-thirties were the first keyboards totally dependent upon electronic amplification, but in 1931, four years before Hammond introduced its electronic tone-wheel organ, the Rickenbacker Co. created the first electronic musical instrument: the "Fry Pan" Steel Guitar. Steel players became the first "electronic musicians."

The steel has developed a lot since birth. There were the National double-neck and Fender three and four necks. Then Bud Isaacs popularized the pedal steel, developed by Paul Bigsby, in 1952. In 1955 Leo Fender began mass producing the famous "Fender 1,000" double-neck pedal steel, with two banks of eight strings each and eight pedals. I worked out the pedal setup used on the Fender 1,000 and wrote the book that presented its 48-pedal-combination chord structures.

During 1986 and 1987 I spent many futile attempts trying to get magnetic pickup systems to track a steel guitar successfully in order to get an accurate steel-to-MIDI interface, but as noted in a variety of articles, this is not an easy task. Add in false triggering caused by crosstalk and the erratic behavior of retriggering when the player is double-picking, and you present nothing but confusion to the MIDI converter.

When I met Kevin Kent and his talented staff at Photon in September '86, I was a despondent, discouraged and very nearly broke steel guitarist. Using their Photon converters, my engineers and I developed the "Steel Guitorchestra," a steel-to-MIDI system that uses *individually string-adjustable* infrared pickups—the only individually adjustable MIDI pickups available for string instruments. This technology puts that string in the center of the infrared beam, which greatly improves speed and accuracy, with *no* false triggering caused by crosstalk. This system lets the player adjust the conversion cycle for each string, individually, according to string gauge and technique. I feel the Steel Guitorchestra has brought some of the steel guitar's finest capabilities to the MIDI world, and immeasurably expanded the steel's repertoire.

What I have always considered the "curse of single note playing" on the steel—the steel bar—has become an unparalleled blessing. Until MIDI, playing single note passages with the steel bar could be compared to playing the keyboard with only your index finger. However, with the Steel Guitorchestra, thanks to its ability to quantize notes to the nearest half-step, a simple one octave slide with the "9th chord Pedal" held down produces a ninth chord—or even seven-note chords like augmented 11 +13th—*at every semi-tone*, if you'd like, more rapidly than the ear can hear it.

One of the great attributes of the steel guitar is its pedals. The pedals enable a player to move, for example, one string up ½ tone, another up 1-½ tones, lower one string 1 tone and two strings ½ tone each, and leave three other strings alone. This cannot be duplicated on any other instrument. With the Steel Guitorchestra's accurate pickups, and its Pitch Bend Mode, triggering a multi-timbral synthesizer by playing a steel with this technique is no problem, and is like hearing an orchestra with pedal voicings. It must be heard to be fully appreciated.

Feel free to contact me for demo tapes and info; if you want to hear what this is all about, send me a note and include $3.70 to help cover cassette and mailing costs. I am interested in hearing from any steel players who want to get into MIDI.

Al Petty
PO Box 308
Overton, TX 75684

Al—Thanks for the info, it seems like the Sept. issue really struck a chord with steel guitar players. Our readers might like to know that Al Petty has been playing steel guitar professionally since 1944 on radio, TV, and records. He has taught, toured with Grand Ole Opry acts, played with Hank Williams, owned a chain of music schools, recorded extensively in Hollywood with J. Burton and Glen Campbell, written books, worked with Fender Amps, and entered the ministry. He is a regular on the PTL and TBN Christian TV Networks; he plans to build a "Learning Center" for teaching the Bible and music, as well as doing research and development. We'd be interested in hearing from other steel players who have gone MIDI—is there electro-country in our future?

Power to the PZM

In reference to Mike Dwyer's article on page 20 of the Aug. '87 **EM** concerning Radio Shack's PZM microphone: on page six of the Radio Shack PZM manual, it's suggested that if the 1.5 Volt AA supply voltage does not deliver sufficient headroom, you can substitute two #23-469 6 Volt batteries in series to give a 12 Volt supply voltage. I would expect that the same 12 Volts could be obtained with our #23-144 12 Volt battery and a metal spring or proper length screw.

On another note, Radio Shack now has an isolation transformer (catalog #273-1374) with a 1:1 turns ratio and 600-900 Ohm impedance, which may solve some problems when feeding audio directly into consoles and other audio gear.

Bob Young
Iowa

On Kawai, the R-100, and Tape Sync

I enjoy your magazine! The information is presented in an enjoyable, understandable way—you help me find my way through the techno-jungle. I do have a few comments on the Kawai R-100 drum machine review (Aug. '87). I bought one two months ago, and was very impressed with the sounds. However, I've experienced a couple of major "bugs" not mentioned in the review.

The machine crashed on me when I was in the record mode at the same time the R-100 was set to External Sync. (Not too handy if you want to drive the R-100 from a sequencer.) A Kawai representative in California told me this had been reported by others, but they have not been able to duplicate the crash so they can't fix the bug (yet). So, avoid doing this and *make backups.* (I learned the hard way when it crashed and I lost everything!)

Secondly, I found the performance of the sync-to-tape to be unuseable; Kawai told me that others also reported this.

On the plus side, I've already bought an alternate sound chip and I love the versatility of changing sounds. Grey Matter Response (the DX7 E! upgrade company) in Tinley Park, IL, is reportedly coming out with a mod for the R-100 that will allow four chip sets on board at once! Yikes.

Back on the down side, I find the step method to be too "mysterious" to be used easily. But for the bucks this is quite a machine. Keep up the great work on the magazine!

Deb E. Danger
Illinois

Deb—Thanks for your comments; I would like to add a few comments of my own concerning sync-to-tape. Short of using SMPTE or SMPTE-like ap-

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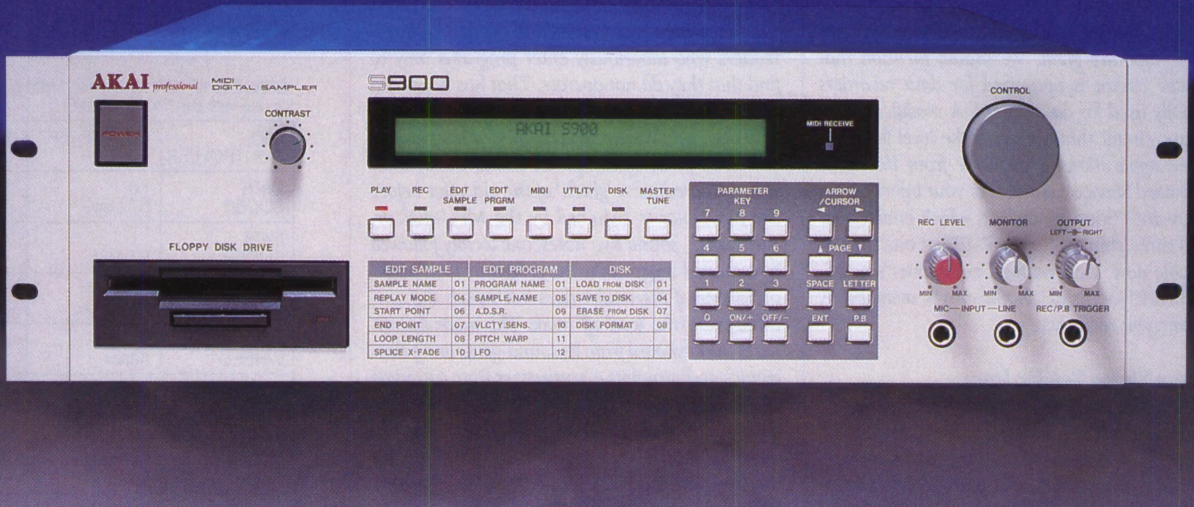
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MIN MAX
MIC—INPUT—LINE
REC/P.B TRIGGER

proaches to sync, tape sync is very much a hit-or-miss proposition until you hit on the right combination of level settings. Having spent close to a decade trying to get sync signals on tape and using them on playback to trigger various electronic music devices, I have noticed that level-setting—both on record and playback—is crucial. Also, leakage from other channels can cause tremendous problems. If possible, leave an empty guard track between the sync track and other audio tracks; if this isn't possible, record only low-level parts on the track adjacent to the sync track.

Also, some tape recorders don't deliver enough level to properly drive a sync-to-tape converter, in which case some kind of preamp is necessary. A phase reversal at the output of the recorder can also be a problem, as can non-defeatable signal processing. If possible, I suggest using a pulse generator to determine what signal levels work best with any sync-to-tape circuit, then looking at the sync signal coming from the tape through an oscilloscope and seeing how it differs compared to the pulse generator output. Then do what you can to make the tape sync signal resemble the pulse output as much as possible—raise or lower level if necessary. Remember also that too much level can be as bad as too little. The consolation to all this is that once you do find the "sweet spot" for the gain settings and so on, you usually won't have to vary them. So, when things do work, take notes so that you can duplicate these conditions whenever you use tape sync.

Regarding your other comments, a representative from Kawai offers the following:

"We have had exactly the software problems described in the letter. A new version of software has just been released that fixes this bug and several others, and also enables the R-100 to output MIDI clock while synching to tape.

"The hints Craig offers for achieving good sync-to-tape are great. We should mention that the tape circuit is optimized for data recorders normally used for data dumps. A modification of the tape circuit that optimizes the level for sync-to-tape applications is available from Kawai or Authorized Service Centers. For your information, Drumware's Soundswitcher, which enables the use of three chip sets in the R-100 at one time, is available now. Concerning Grey Matter's activities, their E! for the K3 should also be available by the time you read this."

Mystery Upset Reader from Jacksonville, Florida

I can't stand it any longer! The software you publish is totally useless (*that will sure surprise the many readers who use the stuff all the time in their work—Ed.*). It is consistently full of bugs and sloppy programming style. Surely there is no one at **EM** who actually bothers to enter it and use it. If there were, you wouldn't publish such trash.

Case in point: The July '87 article "Programming the MPU-401 Interface" includes the program "Poor Man's Split." It would be a poor, poor man indeed who might waste his time entering this program.

Alright (sic); I know that Mr. Penner warns us that "Of course, both voices can't actually sound simultaneously, but . . ." and that in all fairness his program does not set out to do what most people think of a split as doing; but it does a poor job of the task it does try to accomplish. In fact, no program could pull this trick off.

No matter how fast a program can process the MIDI stream, it can't process the data before it receives it. A synthesizer will sound a note long before the computer can react with the appropriate program change command (probably even before the synthesizer transmits the entire Note-On event sequence). This will result in glitches on the note attacks.

"Poor Man's Split" will also cause each note to sound twice, once when the synthesizer keyboard is played, and again as the MPU-401 echoes each command back to the synthesizer's MIDI input. This problem can be solved by sending the MIDI Thru Off command (hex 88) before entering the main program loop. There are other problems with "Poor Man's Split" but there seems little point in debugging a program which simply can never work.

I was a charter subscriber to **EM** because I thought it would uphold the same high standards of its parent magazine, Mix. Boy was I wrong!

(unsigned
no return address)

Unsigned—Well, we agree about one thing; Mix *does uphold high standards. Momentarily reserving some editorial comments, we first let Les Penner, the article's author, reply:*

"I certainly can understand the frustration of readers who laboriously enter programs only to find that they do not operate. That has happened to me. Had the letter writer included a name and address, I would have written him (or her) myself.

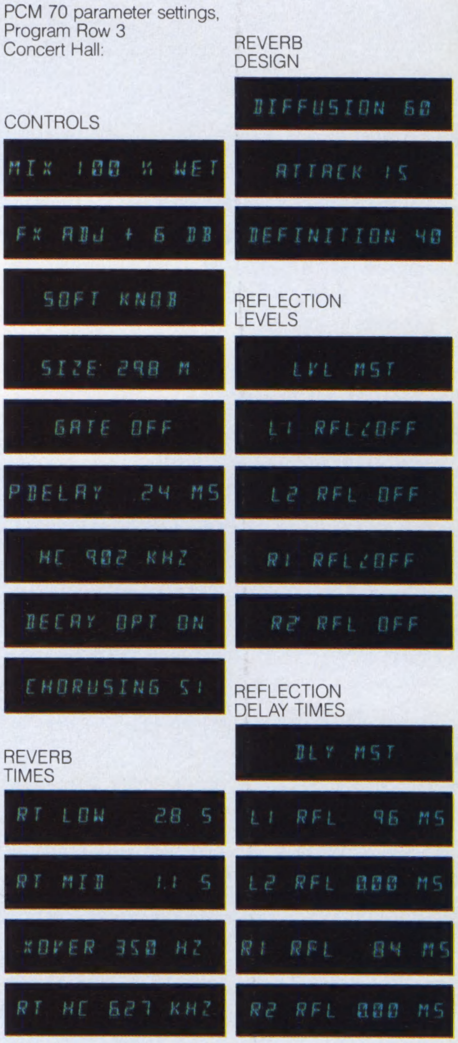
"The person's complaint is that the synthesizer will produce a 'glitch' of the old voice before the new voice is switched by the MPU-401 or, even worse, sound two notes, one locally followed by a second triggered by the program. That might occur only if the reader does not switch the synthesizer into the 'local off' mode. This mode disconnects the keyboard from its sound-generating electronics and prohibits a synthesizer from sounding a note from its own local keyboard. Perhaps the letter-writer's synth doesn't have that mode, but most do. My Roland Juno is not an expensive machine and it has the 'local off' mode. However, it was my oversight not to have pointed out in the article that glitches can occur if you don't turn local mode off. I should not have assumed that this setting would be obvious, nor that everyone would have such a mode on their synth. If the writer has 'local off' mode on his machine, it should be used.

"Regarding speed, I did point out in the article that the program would have a speed problem if it

ENVIR

INTEGRATING DIGITAL

PCM 70 parameter settings,
Program Row 3
Concert Hall:



REVERB
DESIGN

DIFFUSION 60

ATTACK 15

DEFINITION 40

CONTROLS

MIX 100 % WET

FX ADJ + 6 DB

SOFT KNOB

SIZE 29.8 M

GATE OFF

PDELAY 24 MS

HC 9.02 KHZ

DECAY OPT ON

CHORUSING S1

REFLECTION
LEVELS

LVL MST

L1 RFL<OFF

L2 RFL OFF

R1 RFL<OFF

R2 RFL OFF

REFLECTION
DELAY TIMES

DLY MST

L1 RFL 96 MS

L2 RFL 0.00 MS

R1 RFL 84 MS

R2 RFL 0.00 MS

REVERB
TIMES

RT LOW 2.8 S

RT MID 1.1 S

XOVER 350 HZ

RT HC 6.27 KHZ

"SPACE SHIFTER" *Dynamic MIDI* patches
for use with the YAMAHA DX7:

MIDI CONTROLLER	PARAMETER	SCALING	LIMIT VALUES
DATA SLIDER	1.0 RT Low	+13	2.8/ 52
DATA SLIDER	1.1 RT Mid	+22	1.1/ 26
MOD WHEEL	1.2 Crossover	+17	350 Hz/ 4.85 kHz
MOD WHEEL	2.1 Attack	+81	15/ 95
FOOT PEDAL	0.8 Chorusing	+17	51/ 68
LAST VELOCITY	3.1 Lt. V1 Reflection Level	+33	Off/ -8.5
LAST VELOCITY	3.3 Rt. V3 Reflection Level	+30	Off/ -6.5
MIDI CLOCK	0.3 Size	-33	29.8 @ 100 BPM
MIDI CLOCK	4.0 Delay Master	-110	0 @ 100 BPM

"Space Shifter" was written by Lexicon Applications Engineer Will Eggleston.

ONMENTAL IMPACT

EFFECTS INTO MUSICAL PERFORMANCE: A LEXICON APPLICATIONS BRIEF

We developed *Dynamic MIDI®* to take digital effects beyond static environments and flat textures. With it, you can use MIDI controllers to change your music's sonic space or texture as you're playing.

With the PCM 70 Digital Effects Processor, we pioneered the concept of parameter control through MIDI: it's still the most MIDI-responsive effects device available. Each program and register has 10 MIDI patches that assign any controller to any parameter. One controller can change two parameters, or two controllers can affect the same parameter. *Dynamic MIDI* makes possible dramatic unusual techniques that add impact to your music.

Why do we give you more MIDI patches than most effects have parameters? Because the PCM 70's algorithms (like the Concert Hall algorithm shown here) give you more parameters than some units have programs. Complex as it is, Concert Hall is only one of six (seven if you have optional Version 3.0 software) PCM 70 algorithms.

"Space Shifter" is based on Concert Hall: it's a good example of how *Dynamic MIDI* adds new dimensions to performance. The Data Entry slider lengthens the Mid and Low reverb times. The Mod Wheel moves your audience farther away by controlling two parameters at once. As it raises the Crossover frequency, sending more reverb energy into the longer RT Low decay, it lengthens Attack time. The foot pedal choruses the reverb, while keyboard velocity controls the level of left and right reflections.

MIDI clock (included as a controller in our optional Version 3.0 software) adjusts Room Size and Delay Master for different tempos. The chart at bottom left shows that most controllers are scaled to vary the effect from a "minimal" space to one with a powerful impact. But the MIDI Clock patches are negatively scaled: as tempo goes up, size and reflection levels go down, to keep the reverb from "washing over" the beat.

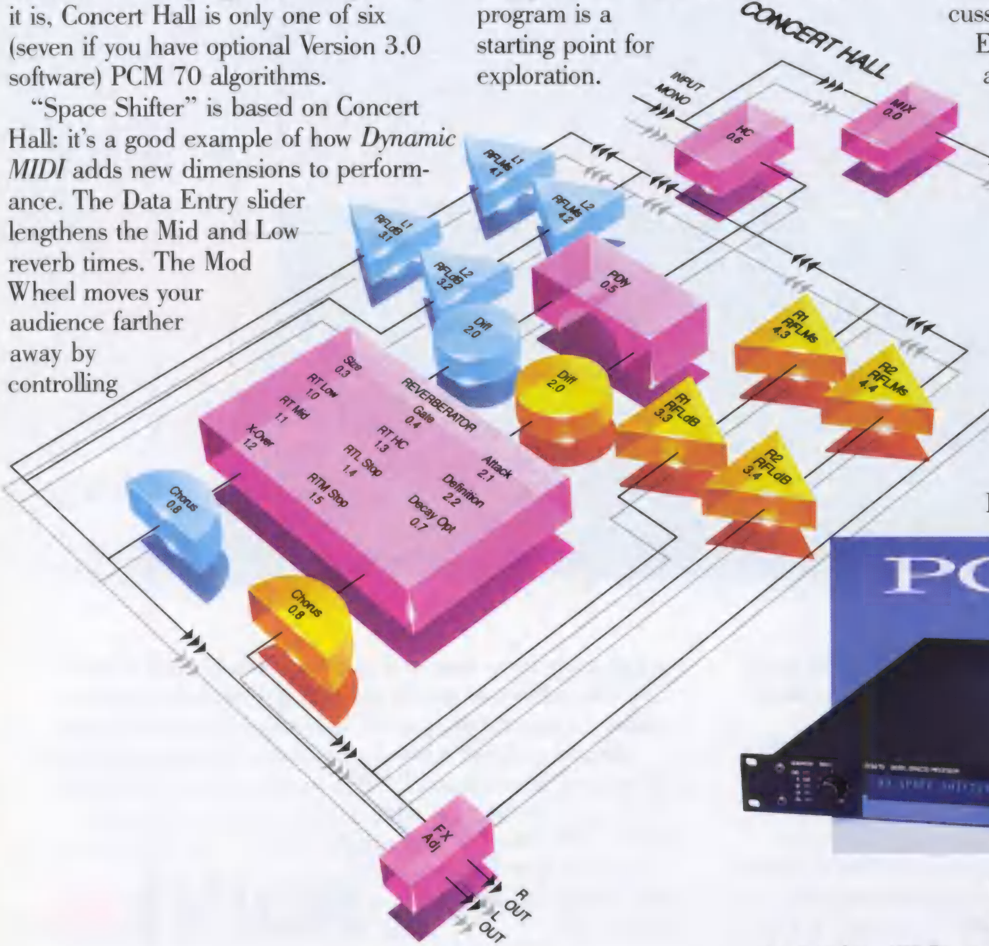
For PCM 70 owners, "Space Shifter's" parameter settings and MIDI patches are in the charts on the left. The tenth MIDI patch is empty: it's yours to experiment with. In fact, the whole program is a starting point for exploration.

Try adjusting the Scaling function to get the polarity and range of control you want. If you need a wider range than a controller offers, you can "double assign" it to the same parameter for up to twice the variation.

These are by no means the only controllers you can use. Pitch Wheels, Sustain pedals and over 120 others are included in *Dynamic MIDI*. Engineers often use Last Note when recording parameter changes to a MIDI sequencer for automated playback during mixdown.

Now a word of warning: If you don't yet own a PCM 70, don't drive yourself crazy trying to duplicate "Space Shifter" or other PCM 70 sounds using less advanced devices. With 30 to 45 parameters, every PCM 70 algorithm gives you multi-dimensional control that's simply not available in simpler units. Concert Hall alone generates many more sounds than we could discuss on one page.

Every PCM 70 has five more algorithms (six with optional Version 3.0 software, including Inverse Room). All of them are equally powerful, equally complex, equally ready to take you into new musical spaces. Which is why thousands of creative studios, innovative producers and productive musicians agree that the PCM 70 has no equal. If you think your music is something special, discover the PCM 70 at your Lexicon dealer.



PCM 70
lexicon

lexicon

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FUNC
SONG
AUDIO SYNC
CHASE FWD
CHASE REV
CHASE SPLIT
FULL FLASH
USER 1
USER 2
BLACK
GO

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1130 Columbia Street, Brea, CA 92621 (714) 990-0909

was not compiled, and encouraged the reader to compile it if at all possible.

"Furthermore, the main thrust of the article was to tutor the reader on how to program for the MPU-401 interface. The program 'Poor Man's Split' was only meant to illustrate such techniques. (Nevertheless, I agree that it should work.) If any reader would like to avoid entering the program or would like the compiled version of it, I would be glad to send them a diskette containing both if they would send me a self-addressed, postage paid diskette mailer and diskette. My address is 25 Shadow Lane, Great Neck, NY 11021."

Additional comments from the editor:
We'd like to thank Les Penner for offering to copy his MPU-401 program for **EM** *readers. Although we try to check out programs that appear in the magazine, we don't have one of every computer/interface/synthesizer at our disposal, so we usually have to rely on our authors to provide us with accurate manuscripts and listings. However, authors are only human and on occasion, a mistake in a program listing will make it all the way to publication. In the event that this occurs we contact the author for a correction as soon as a reader alerts us to the problem; then we send a copy of the correction to all who contact us regarding the problem (provided they give us their address), publish the correction in* **EM** *as soon as possible, and include it in our "Corrections" listing which is enclosed when back issues are ordered. (Commercial software manufacturers have similar problems; totally bug-free software is rare indeed, and it is user feedback that often helps exterminate those bugs.)*

Regarding the usefulness of the programs published in **EM***: of course, any short program is bound to have some limitations, but many people use the free software in* **EM** *to great benefit and practical application. Occasionally, published programs are intended to be more educational than directly applicable. As was pointed out in Les's article, "***. . .** *The Poor Man's Split runs best when compiled under IBM's BASIC Compiler or Microsoft's QuickBasic. Without a compiler, the response will be slow, but you can still learn a lot about programming your MPU-401 from Poor Man's Split."* Electronic Musician *is always looking for good programs to publish and had the angry letter writer sent an address, we could have provided a copy of our author's guidelines in the hopes that the reader would take the positive step of contributing a program rather than merely putting down those who have taken the time and effort to make their own contributions.*

Regarding the unsigned negative letter: we welcome constructive criticism, suggestions for improvement, and differences of opinion, which we share with our readers. However, those who don't respect their own opinions enough to sign a letter don't inspire much respect at this end either. While there will always be some people who think that sending an angry, non-constructive letter somehow makes the world a better place, we're grateful that the overwhelming majority of **EM** *readers believe otherwise, and realize that cooperation, compassion, understanding, and open communication are the ticket to making life better for all of us.*

The Illegal Sweetener

Regarding Jules Ryckebusch's construction article "The $10 Harmonic Sweetener" in the September issue, aside from the circuit being almost identical to that of our patent and our old 602 Aural Exciter (less metering, I/O stages, etc.), there are a few points I believe your readers should be aware of before they rush out for their $10 of parts.

1. The Aphex Aural Exciter circuit is patented. There are *no* other processors, however they describe themselves, that generate new harmonics, so the circuit is not typical of the others, only Aphex. Importantly, *any commercial use* of the device shown violates our patent rights, including performing or selling a record or tape on which the device was used.

2. The clipping circuit shown will generate *odd* harmonics, the addition of which can lead to harsh sound and ear fatigue. Aphex adds only *even* harmonics (except for our Aphex II model, where it's adjustable) known for their warm, musically-rich qualities. Also, instead of clippers, Aural Exciters use a VCA to accurately produce harmonics dynamically proportional to the input, instead of at a fixed threshold.

3. Other "goodies" left out of the circuit (in comparison to our lowest-cost Type E Aural Exciter) include an instrument preamp, variable tuning, a control with metering to prevent overdriving the harmonic circuit (sounds terrible!), and sidechain signal conditioning including limiting and time-domain processing for a rich, airy sound.

It seems therefore that spending "$10" on a circuit that cannot legally be used for any commercial purpose and probably will sound fairly raspy may represent false economy, especially in light of the extremely low price of the newest version of the real thing.

Jon Sanserino
Product Manager
Aphex Systems, Ltd.

Jon—Thanks for the note; I always wondered why Aphex Aural Exciters sound the way they do, and the use of even harmonics makes a lot of sense (have you ever considered modifying that section of the circuit for use as a fuzztone?). Incidentally, Jules had no idea that the circuit he put together was so close to your patent that he was infringing on it, but I suppose that's what happens when you have intelligent people making educated guesses.

Jules Ryckebusch also comments:
"I didn't realize I was that close to your actual circuit as to infringe on your patent. Since I do not plan on manufacturing these, this should not be a

—continued on page 98

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ACCESSORIES

▶**E!** ($399) for the DX7II series is a memory/function expansion retrofit for the DX7IIFD/D/S that adds 256 voice and 128 performance memories; multi-timbral operation with dynamic voice allocation; an internal 16-track sequencer with a 16,000-event capacity; and an advanced, 16-track, polyphonic arpeggiator and auto-chord player. Utilities include an editor for the sequencer and a MIDI monitor that uses the DX's LCD to display incoming MIDI data.

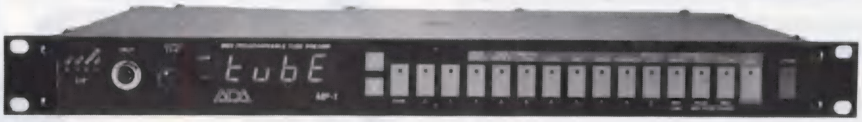
Grey Matter
(formerly Grey Matter Response)
15916 Haven Avenue
Tinley Park, IL 60477
☎ 312 / 349-1889

▶Volume I of the **Sound Sampling Collection** ($41.95) is the first in a series of sounds digitally recorded on compact disc (using Sony equipment) for use with digital samplers. Acoustic instruments are recorded twice each in mono at five-second intervals and include drums, percussion, string bass, violin, trumpet, trombone, flute, clarinet and piano. Melodic instruments are recorded in scalar steps over at least two octaves, and faded after reaching a peak. Instructions and acoustic data are included.

Korg USA, Inc.
89 Frost Street
Westbury, NY 11590
☎ 516 / 333-9100

▶Trigger your Casio SK-1 sampler from a drum machine, synthesizer, or any gate or trigger output with the **SKX Trigger Interface** modification kit ($16.25 incl. s/h). The kit can be wired to play samples at their original pitch for drum sounds, or to sync the SK-1 sequencer to external trigger for chordal or melodic patterns. Easy installation should take less than an hour, with no major surgery. Assembled and tested kits ($24.75 incl. s/h) are also available.

Mescal Music
PO Box 5372
Hercules, CA 94547
☎ 415 / 724-0804



ADA MP-1

AMPLIFIERS

▶The **MP-1** ($699.95) is a programmable tube preamp with 128 memory selections and full MIDI implementation. Voicing modes "Tube-Clean" and "Tube-Distortion" use two 12AX7A low-noise tubes for full compression or maximum saturation in four gain stages; the two-gain-stage Solid State mode bypasses the tubes for clean sounds. Each mode has three front-panel-programmable gain levels. Programmable MIDI parameters include program mapping, channel select, and MIDI In, Out, and Thru. The optional **MC-1 Universal MIDI Foot Controller** ($199.95) accesses all 128 programs.

ADA Signal Processors, Inc.
7303D Edgewater Drive
Oakland CA 94621
☎ 415 / 632-1323
☎ 800 / 241-8888 (outside California)

▶The **PMA™ 70+** 35/100 Watt Stereo Studio Monitor Amplifier ($179.50) for smaller, near-field reference monitors uses a new stepped power supply variation to produce 35 Watts of continuous power (4 to 8 Ohms) and instantaneous output of 100 Watts RMS. The amp measures 7 × 5.25 × 8.25 inches, so two can fit in a 3U rack space to provide four 100-Watt channels. A new design uses "over-sized" steel-case TO-3 output devices for cool operation. Level controls, ¼-inch output jacks, and connectors are rear-panel mounted to prevent accidental alteration; power mains and LED are front-mounted.

Audio Media Research
PO Box 1230
Meridian, MS 39301
☎ 601 / 483-5372

ELECTRONIC PERCUSSION

▶Two new versions of the **EP-1 Electronic Trigger Pedal** ($298) use its triggering mechanism and are compatible with most electronic drums and drum computers. The **EP-3** ($198) has a modified 300CX bass drum pedal mounted on it and the **EPR** ($139) is a non-skid electronic pedal plate that can convert most existing bass pedals into triggers.

Drum Workshop, Inc.
2697 Lavery Ct. Unit #16
Newbury Park, CA 91320
☎ 805 / 499-6863

INSTRUCTIONAL VIDEO

▶**This Business of MIDI** ($39.95) is a 45-minute video tape (VHS or Beta) covering MIDI basics and uses. Topics include: terminology; binary and hex numbering in MIDI; MIDI language structure, decoding and use of MIDI messages; MIDI channels and modes; and a demo synth hook-up and computer-sequencer session. The material is supported with graphics, and an accompanying manual includes: MIDI implementation, message and mode charts; electronic music/MIDI glossary and a binary-decimal-hexidecimal-conversion table.

Soundware of Austin
PO Box 530242
Austin TX 78753
☎ 512 / 339-6502

MIDI ACCESSORIES

▶JLCooper offers three new additions to its **MidiMation** system. **MAGI,™** the Mixer Automation Gain Interface ($2,200 for 16 channels and VCAs) is a 3U rack-mount fader automation device for mixers. Configurable for from eight to 56 channels, it works with either an optional 1U VCA unit that can be patched anywhere into a mixer's audio path; without VCAs, as a control voltage source; or as an internal retrofit for specific boards. Its fader moves can be stored on SAM (see below) or any MIDI sequencer. A hand-held controller has eight fader controls that are bank-switchable to control up to 56 channels, and can perform sub-grouping and muting.

▶**SAM**, the SMPTE Automation Manager ($849), is a RAM-based, SMPTE-locked automation controller. It is a sequencer-like device, dedicated to MIDImute and MAGI, that stores and "plays back" your mixing moves. SAM will lock to tape already striped with any version of time code or lay its own stripe on tape and lock all of its automation memory to that. Automated functions include merging or updating previous moves, read-while-write for overdubs, start/stop information

AFTER TOUCH™

OFFICIAL NEWS FROM THE YAMAHA USERS GROUP NOVEMBER, 1987.

Build a better sequence.

THE QX3 DIGITAL SEQUENCE RECORDER is Yamaha's newest tool for MIDI sequencing. It offers many of the features of the QX1, along with several noticeable improvements.

To begin with, the QX3 has 16 tracks instead of 8, as well as a built-in 3.5″ disk drive. It receives and records all types of MIDI information, including aftertouch and System Exclusive data. And it works with MIDI Song Position Pointer, to allow sync with external clock or tape clock.

With 512K of internal memory, the QX3 almost completely eliminates the delays associated with disk access. And its new panel features make all operations easier and quicker.

There's a 40 x 2 LCD with variable contrast control, a numeric keypad, and keys for Note Value, Note Name and Track Select. There's an Editing Dial for setting tempo and moving through measures or events. Plus, there are two function keys that can be programmed as "key macros." So with one touch, you can execute the operations you use most—up to 128 keystrokes each.

The QX3 records in Real Time and Step Time. But you can also record using Punch-In, either manually or automatically, beginning anywhere—even in the middle of a measure. And this function can be used with the Auto-Locate feature.

It all adds up to a sequencer that combines the professional features of the QX1 with the ease of operation and flexibility of the QX5. And at a suggested list price of $1595.00, it adds up rather well.

Hot Tips

Some voicing tips for the DX7 & DX711D/FD.

1. To get a faster "attack" on string sounds, input a higher number for Rate 1 of the Carrier operators in the algorithm you're using.

2. To add a longer fade-away upon key release, input a lower number for Rate 4 of the Carrier operators in your algorithm.

3. To create "string pad" sounds, use the side-by-side algorithm stacks (numbers 1, 2, 14, 15, etc.). Try using a fixed frequency for one of the Carriers—this makes for good string chorusing.

YAMAHA QX3 DIGITAL SEQUENCE RECORDER.

Questions

Is there a way to save the memory of the MEP4 MIDI Event Processor to tape or disk?

The MEP4 has no cassette interface. But you can use its Bulk Dump function to save its memory to disk via MIDI. All you need is a unit that stores MIDI System Exclusive data, like a MDF1 MIDI Data Filer, or a DX7IIFD (which has a built-in disk drive). The basic operation is described on pages 42–43 of the MEP4 owner manual. Simply make the MIDI connection from the MEP4 to the storage unit—instead of to another MEP4, as described in the manual.

I have a DX100 and I'm having trouble with the saxophone voice in ROM. How do I get it to work?

You're probably referring to the ROM voice called SAX BC. The "BC" stands for "breath controller," and that means the voice has been set up to operate with that controller. If you want to use this voice without a breath controller, go into FUNCTION mode and set the EG BIAS for the BREATH CONTROLLER to OFF. Every internal voice in the DX100 with "BC" as part of its name is preset for the breath controller, and can be changed in this way.

AFTERTOUCH is a monthly newsletter filled with the latest on Yamaha products. Get a year's subscription free by writing to:

AFTERTOUCH,
P.O. Box 7938,
Northridge, CA
91327-7938.

YAMAHA®

Yamaha Music Corporation, USA,
Digital Musical Instrument
Division, P.O. Box 6600, Buena
Park, CA 90622.

for effects, and support as an off-line computer for cue listing and editing. Memory is stored on the striped tape, SAM disk, or any MIDI mass storage device.

▶**SAM Disk** ($995), an automatic archive system, has four sectors of 11,000 moves each per 3½-inch disk, and automatically remembers the last four passes made on SAM. The remote unit saves, protects, aborts and loads moves to SAM. The 1U rack mount disk unit includes a disk drive and LED indicators.

JLCooper Electronics
1931 Pontius Avenue
West Los Angeles, CA 90025
☎ 213 / 473-8771

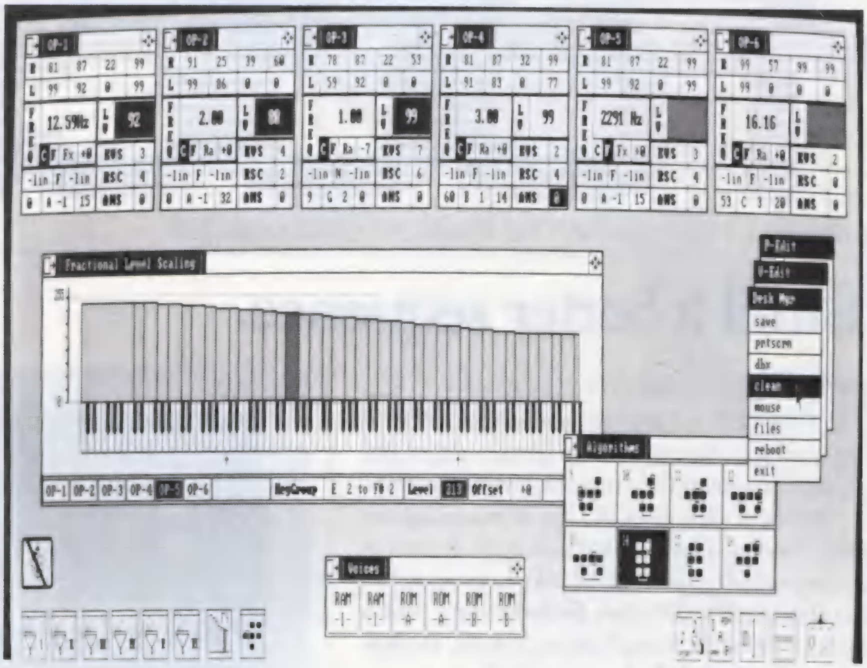
▶The **Studio Plus Two** two-in, six-out MIDI Interface ($275) for all software on the Mac II, Plus, SE or 512, has printer and modem port *thru* switches to obviate cable swapping when switching from MIDI operations to printing or telecommunication. As a MIDI Thru box (with or without the Mac), it allows two flexible configurations of MIDI/modem/printer ins and outs. Its front panel has red and yellow LEDs that show MIDI activity. Price *includes* Mac cables and an AC power converter.

Opcode Systems
444 Ramona
Palo Alto, CA 94301
☎ 415 / 321-8977

LIBRARIANS/PATCH EDITORS

▶The **TX802/DXII Graphic Editing System** for the IBM PC ($249.95) offers sophisticated editing with object-oriented graphics and all windows logically separated for maximum modularity. Graphic Fractional Level Scaling and envelope editors give detailed, visual information. Control multi-timbral capability with the Performance editor; link tone generators for 16-note chords; create microtonal scales; program Control Change and Program Change tables; and access all front-panel functions.

Bacchus Software Systems
2210 Wilshire Blvd. #330
Santa Monica, CA 90403
☎ 213 / 820-9145



Bacchus TX802 Editing System

▶**SPX90.COM** ($27.50 incl. s/h) is a librarian/editor for the Yamaha SPX90 and the IBM (and clones) using the Roland MPU-401 MIDI interface. Via an internal SPX90 switch, the program uses the SPX's MIDI Thru port as a MIDI Out, thus making system exclusive data communication possible.

Burt Fenner
PO Box 35
Lemont, PA 16851
☎ 814 / 863-4409

▶The **MSM 2000** Modular System Memory ($595) stores 2,048 sounds for the Yamaha DX5, DX1, DX7 and RX11. Fast Forward and Rewind buttons scroll through the 64 banks of 32 patches. Within each bank, the user calls up sounds from the keyboard or drum machine and saves a sound from an instrument to the MSM by pressing the Record button. Comes with automatic memory protection through rechargeable batteries, and 544 free sounds. Interfaces for Roland JX8P, JX-10 and Ensoniq ESQ-1 will be available in the near future.

Forat
11514 Ventura Blvd.
Studio City, CA 91604
☎ 818 / 763-3007

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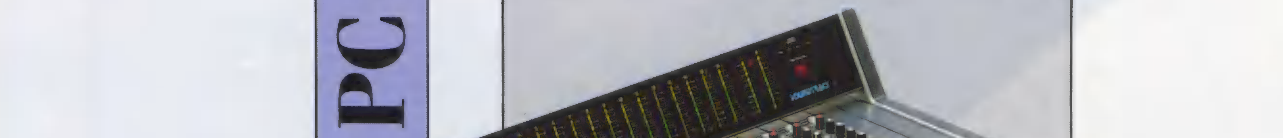
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▶**Performer Version 2** ($395 new, $95 as upgrade) is an update of the popular Macintosh sequencer, Performer 1.22. New tempo implementations include *Multiple Tempo Changes* in a sequence, changes on any tick in a measure, instantaneous or smooth change curves, and the ability to calculate smooth changes between two points. New edits are: *Snip* and *Splice*, which work like Cut and Paste but *move* non-selected data into or out of selected spaces; *Shift*, which moves regions forward or back in time; and *Repeat*, which makes a number of back-to-back copies of a region. Each track independently can have several *Loops* (and nested loops) that begin and end anywhere, regardless of where playback starts, and Version 2 allows you to record while looping. Other features include meter changes, simultaneous use of printer and modem ports allowing simultaneous recording on up to 32 tracks, more sophisticated quantization and other region editing, SMPTE real time display and locked hit points, and more.

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Korg USA Inc.
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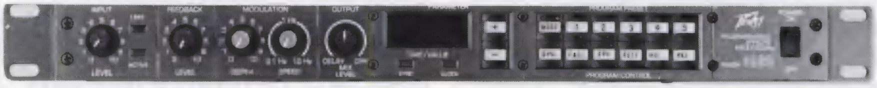
LP Music Group Sound Studio™ 19



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▶The **Sound Studio™ 19** ($649.95) is a 1U rack unit that stores up to 100 programmable guitar effects, including stereo chorus and delay, distortion, six-band EQ, compression, two external effects loops (stereo and mono), and an A-440 tone generator. The different parameter combinations are recallable by a front panel button or with four standard footswitches. All effects are adjustable, programmable, and may be used simultaneously. The unit will drive any guitar amp, power amp, mixing board, or headphones, and comes with a AC power adapter.

LP Music Group
160 Belmont Avenue
Garfield, NJ 07026
☎ 201 / 478-6903

▶The **PEP™ 4530** programmable digital effects processor ($699.50) features continuously adjustable delay from 0.1 to 4095 ms and stores 530 programs. The unit syncs to MIDI clock and accepts external sync signals from drum machines, footswitches, and click tracks, and can be controlled by the Peavey **RMC™ 2000** or **RMC™ 4512** footswitches.

Peavey Electronics Corporation
711 A Street
Meridian, MS 39301
☎ 601 / 483-5365

▶The **SPX90II** ($845) is an upgraded version of the original SPX90 unit that offers 30 highly programmable digital effects including reverb, delay and sampling ("freeze") of available reverb delay, and enhanced modulation. The initial delay has been increased for six program types, including reverb (to 1 sec from 50 ms) and freeze and delay (to 2 seconds from 500 ms). Kits to upgrade SPX90s are available; contact authorized dealers for installation price.

Yamaha Music Corporation, USA
Pro Audio Division
PO Box 6600
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SOFTWARE

▶**ECS** now offers two instructional software series supporting the new IBM Music Feature. *The Beginning Musician Series* ($39.95/course) and *The Intermediate Musician Series* ($39.95 and $79.95/course) are student-tested for clarity and reliability. They both use color graphics and the capabilities of the Music Feature to assist teaching. Beginning courses include pitch memory, keyboard skills, and interval recognition. Intermediate courses address intro to blues, reading, keyboard interval training, fingerings, harmonies, chords, and arpeggios. Programs run on the IBM PC or PC Jr. with 128K RAM, 360K double-sided drive, Music Feature, and a MIDI keyboard.

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▶**Convertifile Plus** ($75) is a file conversion utility that converts Dr. T's *KCS* and Passport *MIDI 4+/8+* files to and from *Music Shop* and *Music Shop for MIDI* files, and converts KCS files to and from MIDI 4+/8+ files, to allow budget music transcription and editing, notational entry of music, and the use of Dr. T's *Algorithmic Composer* software with other products. It is compatible with the Commodore 64/128.

Dr. T's Music Software
220 Boylston Street, Suite 306
Chestnut Hill, MA 02167
☎ 617 / 244-6954

▶The **Synth Factory** disk ($34.95) for the Emax sampler features 95 performance presets using 50 different short, sustained, digital waveforms. These waveforms essentially turn the Emax into a "wavetable" synthesizer; dynamic shaping of the final patch is provided solely by the analog processing on the Emax.

Sound Hound Software
5339 Prospect Rd, Suite 141
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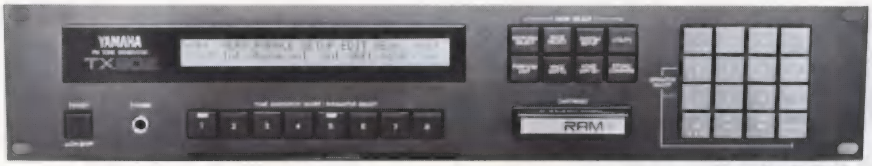

Yamaha TX802

SYNTHESIZERS

▶The 2U rack unit, multi-timbral **TX802 FM Tone Generator** ($1,895) is a rack version of the new six-operator, LSI-technology DX7IID. The unit's 128 preset voices can be edited to create new sounds for storage in 64 user memory locations. Optional RAM cartridge adds 64 voices. All are playable in 16-note polyphony. Up to eight voices can be assigned to a performance; the number of notes playable by each voice and output is selectable. Each of the eight voices has an individual audio output in addition to stereo. Other features include variable random pitch for "analog-rich" sounds, microtuning, fractional scaling, alternative assign mode, level scaling, and more.

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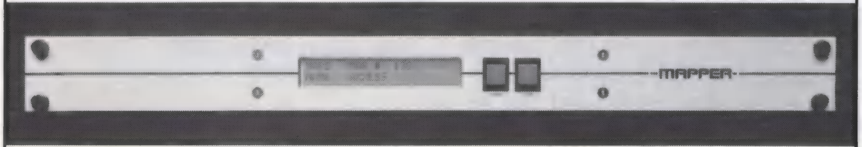

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CALENDAR

▶**SCREAM**, the Southern California Resource for Electro-Acoustic Music, is sponsoring three concerts: *music for real time computer*—a network of synthesizers and computer-controlled audio digitizers played by the composer—by Roger Bourland, Barry Schrader, Carl Stone and Mark Waldrep; *music for live instrument(s) and tape* by Ivan Tcherepnin, Robert Ceely, Samuel Magrill, David Ward-Steinman, Scott Wyatt, Stanley Levine, Beverly Grigsby and Donald Andrus; *tape music* by Paul Lansky, Frederick Lesemann, Wade Perkins, Carla Scaletti, Rodney Oakes and William Schottstaedt; and *tape and robot dancers* (robots choreographed by Margo Apostolos). November 7, 1987 at 1, 4 and 8 p.m., Schoenberg Auditorium at UCLA.

SCREAM
UCLA Department of Music
☎ 213 / 825-4760, 213 / 650-3940

OTHER NEWS

▶**Sharp Corporation** has released the first eraseable optical drive system that uses removeable media. Reported to be the first time such a product has been offered to general users, the Sharp system is based on reinforced glass substrates that supposedly lengthen the life of a disc to about ten years. Each optical disk holds 640 Megabytes of data, has a 2.5 second load/unload time, and can withstand more than one million write/erase cycles. It is expected to be available in November at a price of 1,000,000 Yen (about $7,150 at current exchange rates).

All prices are suggested retail prices, as supplied by the manufacturers. All prices and specifications are subject to change without notice. Inclusion of product information and manufacturers in this magazine does not necessarily constitute a recommendation by **Electronic Musician** *magazine or its staff; we suggest that all mail order purchases be COD. Contact manufacturers for further information.* EM

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★★★★★	*The cream of the crop—offers exceptional value or vision*
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★★★	*Solid, workmanlike product*
★★	*Below-average for its field; often flawed in some way*
★	*Has serious problems—try before you buy!*

We would like to remind you that these are opinions, not gospel, and as always, **EM** *is a communications medium that welcomes opposing viewpoints.*

▶Dr. T's Atari ST 4-Op Deluxe ($129)

★★★★

Programmer Bob Melvin has done it again: 4-Op Deluxe, a patch editor/librarian for Yamaha's current crop of four-operator FM synths, maintains the solid feel and affordable price of his other Atari ST patch editor/librarians. The program is not high on visual stimulation due to its basic columnar arrangements of data, but clever use of the mouse, multiple screens, and "mouseable" envelope generator graphs combine to get the job done.

The 4-Op Deluxe disk actually contains three main programs: one for the DX21/27/100, one for the FB-01, and one for the TX81Z. All include a *voice bank* screen, a *voice edit* screen, and a *system setup* screen. The FB-01 and TX81Z programs have extra screens for each synth's additional capabilities. A utility program for converting DX21/27/100 voices to FB-01 voices is also included.

Rearranging voices into custom banks is easy, although it would be nice if more than one TX81Z or DX21/27/100 bank could be displayed at a time (as is the case with the FB-01 program). Up to eight banks (depending on which program you're using) can be loaded into RAM for fast access.

The voice edit screen is a simple, but well-arranged, display of all the voice parameters for a patch. Bob uses the mouse very effectively; it can select a parameter to change, raise or lower the number, and play any note at any velocity level to hear the effects of changes (fun stuff). The four envelope generator graphs are superimposed for easy comparison, with the active operator distinguished by color, or with a monochrome monitor, by the type of line used. The mouse can grab and move points on the graphs for very fast editing. When using a keyboardless expander module like the TX81Z or FB-01, a flexible "merge" feature allows a master keyboard to sound the synth you're editing.

A randomizing function can generate automatic patch variations; any combination of parameters can be randomized, and the percentage of deviation from the original settings is controllable.

The FB-01 and TX81Z programs also allow editing and storing of performance parameters. These include multi-timbral "instrument" assignments (by number only, not by name); upper and lower limits of each voice for splits; the number of notes each instrument claims; and detune, volume, and octave shift settings for each instrument. The TX81Z's program has additional screens for working with microtonal tuning, and for setting delay, pan, and chord mapping effects.

4-Op Deluxe is copy-protected, and it does not present the user with standard GEM desktop menus. Because of the latter, desk accessories will not work with this program. However, users of Dr. T's Keyboard-Controlled Sequencer will be glad to know that plans are afoot to allow Bob's programs to run inside KCS.

It's difficult (and in the case of the FB-01, impossible) to program the Yamaha four-operator synths from their own front panels. 4-Op Deluxe comes to the rescue in a sensible and straightforward manner. With its clever mouse control, and ability to store patches, performance parameters, and microtonal tunings on inexpensive diskettes, this is a program that really opens up the four-operator Yamaha synths for sonic experimentation.

—Jamie Krutz

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▶Iota Systems Midi-Fader ($499) ★★★★★

MIDI-controlled mixing automation is finally coming of age. Unfortunately, many existing MIDI mixers are either limited in scope (they only do mutes and routings, or "snapshot" levels), or are relatively expensive. The Midi-Fader, however, manages to be both comprehensive and reasonably priced.

Midi-Fader is not a mixer itself, but a rack mount accessory used in conjunction with a conventional mixer. The unit's eight MIDI-controlled attenuators, each with its own audio input and output, can patch between an audio source and its associated mixer channel or into each mixer channel's "insert" loop. The "faders" (not physical faders, but graphic representations of level settings of the unit's electronic attenuators, displayed on an LCD) can be operated manually (one at a time) from a front-panel knob, or via MIDI program changes, controller changes, or notes. Midi-Fader offers *snapshot* mode, in which MIDI program changes cause all eight faders to move to new settings simultaneously (128 program snapshots can be stored in RAM); and *real time* mode, in which controller values and/or note velocities can be used to move faders individually. Both modes can be used at the same time, which provides great flexibility and makes very efficient use of the MIDI data stream.

The rear panel includes eight three-conductor jacks; the "tip" connector of each jack feeds the corresponding fader's input, while the "ring" connector carries the output. This corresponds with the way insert jacks are wired on some popular mixers, so with these mixers, all you need to hook up the Midi-Fader is eight stereo cables. For mixers with a different insert setup (or none at all), other cables can be purchased from the manufacturer, or you can make your own cables (the latter is a pain, but you only have to do it once). The front panel contains a continuous knob with adjustable sensitivity, a two-line-by-16-character LCD, a power switch, and six programming buttons. Like most MIDI devices, the buttons have multiple functions, and their purpose changes with context. The LCD indicates parameters as you do your programming, and also provides a "bar-graph" display showing the levels of the eight "faders."

Setting up the Midi-Fader is fairly complex, but the manual helps a lot. First you set two software switches that tell the unit to accept program change or level data, or both, over MIDI. Then you choose a MIDI channel over which the unit will receive program changes. Next, you choose MIDI channels for each of the faders, over which they will accept controller or note data. Finally, you assign a particular controller number or note number to each fader—if you assign a controller, the fader level will correspond to the controller value. If you assign a note, the fader will read the note's velocity. In addition, a second controller can be assigned to each fader to mute it.

Each attenuator divides its overall level range into 128 steps. A controller or velocity value of 128 gives zero attenuation, while a value of 0 gives 80 dB of attenuation. At the top 16 dB of each fader's range, the attenuation progresses in ¼-dB steps; the next 16 dB are in ½-dB steps; the next 24 dB in 1-dB steps, and the bottom 24 dB in steps ranging from 2 dB to 8 dB.

Other features of note include a "fader change rate" control that determines how quickly a move will be carried out—whether it's a scene change or an individual event—over a range of 1 to 128 milliseconds. Any fader can be muted or soloed at any time using front panel controls.

In addition to receiving data, Midi-Fader can *send* MIDI data, which is useful in several ways. The contents of the program memories can be sent over System Exclusive, either one at a time or all together. There is also a command for sending the setup data itself, so that with appropriate software, a user can keep a library of programs and setups on disk. If you are using more than one Midi-Fader, you can assign a different unit number to each, to ensure that each one gets the right System Exclusive data. When a program is recalled or a fader is operated from the front panel, the corresponding MIDI information can be sent by the unit, so that front panel moves can be recorded by a sequencer.

Speaking of sequencers, a unique feature allows the unit to send all eight fader values (notes or controllers) over MIDI once every second, so they can be recorded. Very few sequencers have the ability to "chase" controller values (i.e., if a sequence is started in the middle, the sequencer will find the last value of every controller and execute it prior to starting), so this option insures that the level settings are part of the sequence, and the proper settings are never more than a second away from any starting point.

The low price necessitates some design trade-offs, but they all make sense. Since the faders are not continuous but rather jump from level to level, a certain amount of garbage (sometimes called "zipper noise") is generated whenever a fader is moved. It is possible to hear this noise if you monitor a simple waveform (like a sustained FM bell) at very high gain, but under normal circumstances, especially with multiple voices or any kind of reverb, the sound is inaudible. Residual noise, on the other hand, is for all practical purposes nonexistent.

What I'd like to see next is an inexpensive control box for the device (and others like it) that does nothing but generate controller data. Meanwhile, for an inexpensive unit, the Midi-Fader is exceptionally well-designed, and the MIDI implementation, which lends itself to effective use with just about any sequencer or live situation, is brilliant. At this price, most studios will want to buy two.

(Author's note: during the R&D phase of Midi-Fader, the manufacturer issued a public call, over the PAN telecommunications network, for input regarding features that potential users would like to see in the device. I responded to that invitation, and contributed

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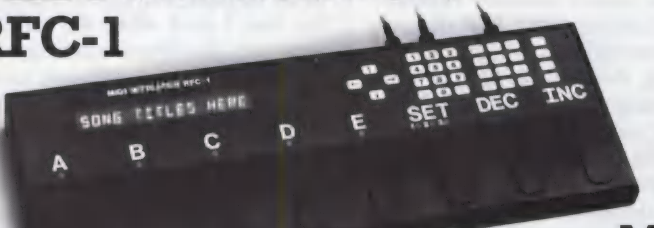

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several ideas. I was subsequently a Beta tester for the product, and for my troubles, got to keep the Beta test unit. The editor has worked with the unit, agrees with my conclusions, and does not consider my situation a conflict of interest.) *—Paul D. Lehrman*

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☎ 702 / 831-6302

▶*The Korg DSS-1 Sampler: Making It Happen*, by Lorenz M. Rychner and Charles Mead, Alexander Publishing, 1987 ($34.95) ★★★★★

One of the drawbacks of technical sophistication is often complexity, and Korg's DSS-1 Digital Sampling Synthesizer is a sophisticated instrument. It's a full-featured synthesizer *and* a no-kidding 12-bit sampler that stores its samples in a clever hierarchy to maximize their potential in a number of ways. This makes the DSS—especially for the computer-innocent—kind of tricky to learn and use.

This book, though, lifts the veil from the DSS's secrets to give even the novice access to the instrument's full potential. The readable (ring-bound, so it lays flat), 212-page guide explains all the DSS functions in an order that makes sense and clears the user's way through the trickier operations involved in sampling sounds and processing them into musicality. Starting by admitting the DSS is in fact a computer, the authors introduce hardware/software basics (input, output, RAM, disk storage, etc.) and an intelligent approach to memory limitations, then offer the first of many lucid sound sampling primers that cover rate, frequency response, and the like. By the end of chapter four, even a slow learner would have a good idea of what was going on.

A helpful discussion of the complex way the DSS's sounds are organized, stored, shared, labeled, programmed (i.e. shaped by the synthesizer) and called out to play precedes a concrete explication of these ideas through analysis of a Korg factory disk. Six chapters (11-16) detail a much-needed tutorial on getting sounds onto and off of disk (despite all the funny disguises the DSS makes them wear and the aliases they use). Lorenz and Rychner put the third degree to Sounds, Systems and Multi Sounds and end up with a full confession of their hideouts and operations.

If this sounds like a lot of theory, it is. But the authors present these absolutely necessary concepts and housekeeping tidbits in a colloquial, amusing style and honest, straightforward manner—almost sinking to outright DSS-bashing in discussing the unit's limitations. It keeps a reader's attitude in good humor to be in the middle of a lesson on sample editing and see a line like, "It turns out the process of 'getting' a sound from within a multi sound caused the DSS-1 brain to 'forget' that it has the complete multi sound in memory. . . ." Yeah . . . if I had this book when I got my DSS I could have avoided a lot of lonely winter nights in a small drafty room trying to figure *that* one out.

The manual does get to operating the DSS, including everything from sampling to saving. It offers nice, friendly, step-by-step walk-throughs of the trickier stuff, hints and tips on disk labeling, sound gathering (record a drum in the fireplace, but "please—extinguish the fire first, I can't afford the liability insurance . . ."), the numerous editing tricks of the DSS, and using the synthesizer and subtractive synthesis functions. It includes useful outlines of the physics of sound, the DSS's harmonic synthesis function (and its limitations) and the nature of the instrument's five on-board waveforms. The book finishes up with quick discussions of disks, MIDI, and some handy reference tables.

Whether you already own a DSS-1 or are considering buying one of these flexible machines, go for this guide. *—Tim Tully*

Alexander Publishing
14536 Roscoe Blvd., Suite 110
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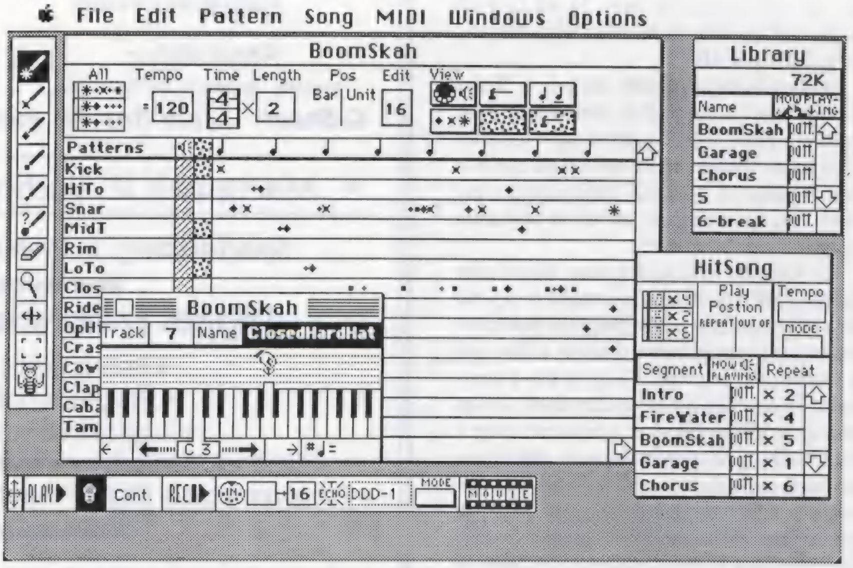

Intelligent Music UpBeat Rhythm Programmer

▶Intelligent Music UpBeat Rhythm Programmer for MIDI Drum Machines and Synthesizers ($150) ★★★★

UpBeat is a novel, Macintosh-based sequencer from Intelligent Music (who also make *M* and *Jam Factory*) for MIDI drum machines (and synths). Imagine splitting off the sound generators from the programming section of your drum machine, and using full-feature Mac computer software to help you do the programming—or even generate random fills. The result is a package that's part sequencer, part drum machine programmer, and part "intelligent instrument" that is going to give a lot of people a lot of fun. Do we really *need* a sequencer dedicated to drum sounds? I didn't think so until UpBeat came along, but this program makes drum programming fun and adds an element of instant gratification not found when endlessly switching functions with conventional drum machines.

The manual contains a "Jumping Right In" section that in minutes has you pointing-and-clicking out drum patterns that your drum machine plays as soon as you click, complete with mute, solo, dynamics (velocity sensitivity) and some pretty nifty automatic fill functions. Not only can you *see* more of the pattern you're programming than with any drum machine I know of, but the range of control UpBeat offers is most impressive. Take the automatic fills, for example. You can control which instrument does the fill ("fill" a snare pattern with toms, for instance, or a kick drum with handclaps), the probability with which fill notes will occur, the number of beats on which a fill can play between written drum notes, the speed of the fill notes, their quantization, the probability of *five* different volumes of fill occurring, and on and on. For the regular, non-fill beats, you can "paint" them on a clear, readable track sheet-like *Pattern Window* as your drumbox (or synth) plays. The same volume levels are available, as are controls for tempo, meter, measure length, number of sub-beats per measure, and more. Rhythmic subtleties come easy: you can cut and paste or *shift* notes or whole tracks by as little as 1/384th of a measure (at 120 BPM, that's 5 milliseconds), to put that backbeat *right* where you want it.

Linking the patterns you create into a *song* is easy in two ways: easy to do, via the standard Macintosh click-and-drag process; and easy to see and modify, by dint of a song window that, for your compositional pleasure, arranges in a column all the patterns and numbers of times they each repeat. Much of the ease of use can be attributed to the manual, which is readable, logical, well-indexed (!), and complete.

My only reservation concerns the linking of UpBeat to the rest of the world. It is an intelligent instrument in itself, but it is also a sequencer. It saves its performances according to the recent MIDI file specification, so files can be moved into and out of the tracks of other sequencers that support the specification. (You would save your drum sequence on disk and then recall that file when running a different sequencer program—so make sure your general purpose MIDI sequencer can read MIDI file spec sequences.) Yet composers with only one computer cannot create or edit UpBeat sequences *simultaneously* with other tracks of their usual sequencer. I'm not sure whether UpBeat thinks it's an intelligent instrument or a sequencer, but it generally is so full of good stuff, I'm sure it will find a comfortable niche next to a lot of drum machines.

—Tim Tully

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▶Synthetic Productions "Cartridge 3" Casio RAM Cartridge with 64 Programs ($69.95) ★★★★★

Andrew Schlesinger's latest cartridge for the CZ-101 maintains the same high standards evidenced in Cartridge 2 of the series (reviewed, with Cartridge 1, in the Feb. '87 issue). I would rate at least half the sounds in each of the four 16-patch banks as *outstanding*, and nothing sounds even remotely like "filler." I immediately went and killed the vibrato on some patches, of course, but that's standard operating procedure for my musical tastes with the CZ-101.

The selection doesn't include a lot of imitative synthesis voices; even the "New Acoustic Grand" patch, for example, doesn't sound much like an acoustic grand—but that doesn't make the sound that *is* there any less useable. There are the usual Casio struck/plucked types of sounds, but also some gentler timbres that recall analog synthesizers. Of the basses, the "TX Bass" and "Upright" patches are particularly strong. Save for "Overdrive" and a couple others, there are not a lot of lead voices; the collection definitely favors chordal/pad/percussive voicings for the first three banks.

The fourth bank has an offbeat collection of novelty sounds, special effects, and even an "I" sound that you'd swear was sampled. While I don't see a lot of musical use for "Sick Cat" or the sound of a bouncing ping-pong ball (and I almost took off one star in the ratings because of this), there's no denying that even these sounds are solid examples of unusual programming techniques. Besides, for those who use the CZ for jingles and such, these effects might actually be the major attraction.

The patches come in an EZ-CZ RAM cartridge, which is larger and heavier than competing cartridges. While not my first choice for a CZ cartridge, so far it (and its predecessors) have worked as advertised; I do feel a little insecure about the weight it puts on the CZ connector, though. *(Editor's note: Andrew Schlesinger reports that he has sold over 2,000 of these cartridges with no reported problems.)*

But the star of this show are the sounds, and they reflect a lot of programming experience. These are as good as any set of sounds I've heard for the CZ-101.

—Craig Anderton

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Why do some samples sound cleaner than others? A lot of it has to do with choosing the right sampling rate—and we're gonna tell you how to find that exact right sampling rate when you're sampling into the Akai S900.

Optimizing S900 Sample Rates

BY DAVID KEMPTON

Akai's S900 is a wonderful sampler with all kinds of features for the samplist who wants a powerful yet easy-to-use package. For example, since the technical aspects of sampling may be confusing to a beginner, Akai has tried to make life a little easier by defining the sampling *rate* (the number of times per second at which the sampled sound is converted into digital information) in terms of *bandwidth*, expressed in Hertz. This way, a musician can continue to think of sounds in familiar terms, and not have to translate bandwidth to sample rate when it's time to sample. This design is a real help, but still leaves us with a bit of a problem.

Sampling theory states that any sample rate faster than the Nyquist limit (twice the highest frequency present in the sampled sound) will generate an acceptable sample. Experience, however, shows that to optimize the quality of a sample, the rate should also be a whole-number multiple of the fundamental frequency of the sampled tone (440 Hz × 2, 3, 4 . . . etc.), in order to avoid harmonic distortion of the sample (see sidebar). Problematically, the S900 displays only the bandwidth, and not the actual sample rate. There *is*, however, a way to get the information we need. Examine the functions available from the *sample edit* menu on the S900 and you'll see that the *end-point-page* displays the actual *number* of samples generated. So if we create a sample, for example, with a sample length that is exactly 1,000 milliseconds (one second) long, and the *end-point-page* displays the number of samples, we then know the *number of samples per second*! Problem solved.

***David Kempton** studied synthesis in the early '70s at Mills College in Oakland after studying sarod with Ali Akbar Khan. He has performed or recorded with artists as diverse as Willie Bobo, Sonny Simmons, Mike Nesmith, Sam and Dave, and Essra Mohawk. He owns The Soundsmith, a MIDI-SMPTE-digital (PCM 2-track) electronic music production facility in Monterey, CA; recently released a cassette album* The Primary Trigrams of the I Ching; *and performs regularly with the Roger Eddy Band, a fusion group.*

If we go a step further, and make some more one-second-long samples, first at a 16,000 Hz bandwidth, then at 15,999, 15,998 and so forth, we discover that the S900 does *not* in fact generate a fully continuous stream of sample rates, but a set of rates, eight Hz apart. It samples at whichever of these rates is closest to 2.5 × the stated bandwidth.

SO WHAT?

The S900 allows over 4,000 sample rates, so you might wonder—considering that most samplers get along just fine with two or three rates—why we need to set the sample rate so precisely. As it turns out, picking the optimum sample rate becomes pretty important when you're trying to squeeze a few more bytes out of memory to make room for that Tyrannosaurus-Rex-meets-Froggy-the-Gremlin sound in the program with your favorite Crumbhorn and slide pickle duet, and even more so when mysterious distortion ruins an exquisite wind chime. We know frequency response is more limited, and the quality of sound deteriorates, when the bandwidth is lowered. (Though for lower-pitched sounds this is not usually a problem because a relatively low bandwidth can still capture 64 or 100 harmonics, which is more than most sounds need to sound natural.) The sound will also be adversely affected if the sampling rate is not a multiple of the period of the sample; the solution is to sample at a rate that's an exact multiple of the sample's fundamental frequency. This causes the aliasing frequencies to fall within the harmonic spectrum of the original sound, which effectively causes them to go away. See **Fig. 1** in the sidebar.

In order to sample at the most appropriate rate, we need to know which sample rates are exact multiples of the fundamental frequency of a given pitch, and which bandwidths cause the S900 to sample at those rates. Some pitches (like low A) happen to have many exact multiples among the S900 sample rates, while some pitches (like A-440) have *no* directly corresponding sample rate. What we need is a table of frequencies and associated sample rates. I'm far too lazy to hand-calculate all that nonsense, so I created a Turbo Pascal program to do it for me. For

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each note, the program determines which of the S900's sample rates are exact or nearly exact (it's an imperfect world, you know) multiples of the note, and at what bandwidth you must sample to use that rate.

We felt publishing the *results* of the program (**Fig. 2**) was much more generally useful than publishing the program listing, but if anyone feels the need to check my logic or modify the routine, see the mailing information at the end of the article. The data shown represents the "best" values, defined as those with the least possible error at the highest and lowest bandwidth, for each frequency, along with a middle frequency if justified. Notice how a low note may only need a very limited bandwidth to get over 100 harmonics, while a high pitch may only be able to reach the second or third harmonic at even full bandwidth. In reducing the information from the 50-page printed listing, I've kept the lowest frequency that produces a specific number of harmonics (typically 16, 64, or 100). Nothing is gained by sampling at a faster rate unless it reduces distortion (lower error factor) or increases the number of harmonics that are included.

SO WHAT DO I DO WITH IT?

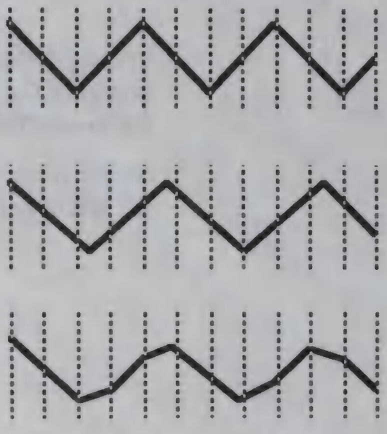
Using the table is really simple, if your sample is in tune. Just listen to the sound to decide how high the bandwidth needs to be, check the table, find the fundamental pitch, and select the lowest bandwidth that is as high or higher than the bandwidth you need. Set the bandwidth in the *sample* page and proceed to create your sample. You should find it a little easier to get good loops, and the aliasing distortion should be noticably reduced. If the frequency you are sampling is *not* in tune, you can either re-tune the sample

Sampling Distortion: Why Exact Sample Rate is Important

The sampling process takes a real-world (analog) sound, which it sees as a continuous, smooth voltage (a signal) and converts it into a set of binary numbers. These numbers represent the signal as a set of whole numbers that are as close as the sampler can get to the original. In the real world, numbers like 2.6, 3.3333333 or 2.003 lie "in the cracks." The sampler can only represent these as integers, so they become 3, 3 and 2, respectively.

This "error" information causes the least distortion when the sample can complete exactly one cycle as the sampler is retrieving another "slice" of the sound. The distortion is more evident as the difference gets greater, until eventually the signal starts to approach another synchronizing point. In **Fig. 1**, vertical lines are sample points and the wavy lines are the waveforms of a signal or sample.

—D.K.



Properly synchronized signal: the "peak" and "trough" of the wave are aligned with the sample times, so distortion is minimized.

Improperly synchronized signal: the "peak" and "trough" often fall between the sample points, so an inaccurate waveform results.

Waveform resulting from the samples (above). Note the way the wave has become irregularly distorted.

Fig. 1 *How sampling rate affects distortion.*

Akai S900 Bandwidth-to-Sample-Rate Converter and Optimizer Chart

Pitch	Freq. (Hz)	Key #	Band-width	Sample Rate	Harmonics
A 0	27.50	21	3036	7590	110 Exact
A 0	27.50	21	3080	7700	112 Exact
A 0	27.50	21	15972	39930	580 Exact
Bb0	29.13	22	4662	11654	160 Exact
Bb0	29.13	22	9323	23308	319 Exact
Bb0	29.13	22	13985	34962	480 Exact
B 0	30.87	23	6174	15434	200 Exact
B 0	30.87	23	12347	30868	399 Exact
C 1	32.70	24	4801	12002	146
C 1	32.70	24	14402	36006	440
Db1	34.65	25	3465	8662	100 Exact
Db1	34.65	25	6930	17324	200 Exact
Db1	34.65	25	10394	25986	299 Exact
Db1	34.65	25	13859	34648	399 Exact
D 1	36.71	26	7342	18354	200 Exact
D 1	36.71	26	14683	36708	399 Exact
Eb1	38.89	27	3282	8206	84
Eb1	38.89	27	6565	16412	168
Eb1	38.89	27	14701	36752	378
E 1	41.20	28	4384	10960	106
E 1	41.20	28	8768	21920	212
E 1	41.20	28	15426	38566	374
F 1	43.65	29	4138	10346	94
F 1	43.65	29	9185	22962	210
F 1	43.65	29	14231	35578	325
Gb1	46.29	30	3203	8008	69
Gb1	46.29	30	9610	24024	207
Gb1	46.29	30	14479	36198	312
G 1	49.00	31	3018	7546	61
G 1	49.00	31	15895	39738	324
Ab1	51.91	32	3343	8358	64
Ab1	51.91	32	6686	16716	128
Ab1	51.91	32	13850	34626	266
A 1	55.00	33	3036	7590	55 Exact
A 1	55.00	33	5500	13750	100 Exact
A 1	55.00	33	11000	27500	200 Exact
A 1	55.00	33	15972	39930	290 Exact
Bb1	58.27	34	4662	11654	80 Exact
Bb1	58.27	34	9323	23308	159 Exact
Bb1	58.27	34	13985	34962	240 Exact
B 1	61.73	35	9878	24694	160 Exact
B 1	61.73	35	13977	34942	226
C 2	65.41	36	6959	17398	106
C 2	65.41	36	13918	34796	212
Db2	69.30	37	3465	8662	50 Exact
Db2	69.30	37	6930	17324	100 Exact
Db2	69.30	37	10394	25986	149 Exact
Db2	69.30	37	13859	34648	199 Exact
D 2	73.42	38	7342	18354	100 Exact
D 2	73.42	38	14683	36708	199 Exact
Eb2	77.78	39	4854	12134	62
Eb2	77.78	39	14841	37102	190
E 2	82.41	40	3725	9312	45
E 2	82.41	40	9394	23486	113
E 2	82.41	40	15064	37660	182
F 2	87.31	41	3527	8818	40
F 2	87.31	41	11490	28724	131
F 2	87.31	41	15925	39812	182
Gb2	92.50	42	15577	38942	168
G 2	98.00	43	3018	7546	30
G 2	98.00	43	6272	15680	64
G 2	98.00	43	12073	30184	123
Ab2	103.83	44	3821	9552	36
Ab2	103.83	44	6686	16716	64
Ab2	103.83	44	13373	33432	128
A 2	110.00	45	3080	7700	28 Exact
A 2	110.00	45	7084	17710	64 Exact
A 2	110.00	45	15972	39930	145 Exact
Bb2	116.54	46	5687	14218	48
Bb2	116.54	46	11374	28436	97
Bb2	116.54	46	15337	38342	131
B 2	123.47	47	5976	14940	48
B 2	123.47	47	15310	38276	123
C 3	130.81	48	6436	16090	49
C 3	130.81	48	12872	32180	98
Db3	138.59	49	4878	12196	35
Db3	138.59	49	7318	18294	52
Db3	138.59	49	12196	30490	87
D 3	146.83	50	7342	18354	50 Exact
D 3	146.83	50	14683	36708	99 Exact
Eb3	155.56	51	7405	18512	47
Eb3	155.56	51	14810	37024	95
E 3	164.81	52	5670	14174	34
E 3	164.81	52	13119	32798	79
F 3	174.61	53	7962	19906	45
F 3	174.61	53	15925	39812	91
Gb3	185.00	54	3108	7770	16
Gb3	185.00	54	8732	21830	47
Gb3	185.00	54	15910	39774	86
G 3	196.00	55	3136	7840	16
G 3	196.00	55	11995	29988	61
Ab3	207.65	56	3821	9552	18
Ab3	207.65	56	7642	19104	36
Ab3	207.65	56	13373	33432	64
A 3	220.00	57	3608	9020	16 Exact
A 3	220.00	57	14168	35420	64 Exact
Bb3	233.08	58	5687	14218	24
Bb3	233.08	58	13612	34030	58
B 3	246.94	59	15310	38276	61
C 4	261.63	60	12872	32180	49
Db4	277.18	61	7872	19680	28
Db4	277.18	61	15744	39360	56
D 4	293.66	62	3524	8810	12
D 4	293.66	62	15388	38470	52
Eb4	311.13	63	15681	39202	50
E 4	329.63	64	5670	14174	17
E 4	329.63	64	14899	37248	45
F 4	349.23	65	7962	19906	22
F 4	349.23	65	15925	39812	45
Gb4	369.99	66	3108	7770	8
Gb4	369.99	66	5920	14800	16
Gb4	369.99	66	12284	30710	33
G 4	391.99	67	3136	7840	8
G 4	391.99	67	11760	29400	30
Ab4	415.30	68	15782	39454	38
A4	NO MATCHING RATE				
Bb4	466.16	70	13612	34030	29
B 4	493.88	71	3358	8396	6
B 4	493.88	71	13631	34078	27
C 5	523.25	72	3349	8372	6
C 5	523.25	72	15070	37674	28
Db5	554.36	73	4878	12196	8
Db5	554.36	73	12196	30490	21
D 5	587.33	74	3524	8810	6
D 5	587.33	74	9867	24668	16
D 5	587.33	74	12686	31716	21
Eb5	622.25	75	15681	39202	25
E 5	659.25	76	13449	33622	20
F 5	698.46	77	15925	39812	22
Gb5	739.99	78	3256	8140	4
Gb5	739.99	78	11840	29600	16
G 5	783.99	79	3136	7840	4
G 5	783.99	79	11917	29792	15
Ab5	830.61	80	11961	29902	14
A5	NO MATCHING RATE				
Bb5	932.33	82	4475	11188	4
Bb5	932.33	82	13426	33564	14
B 5	987.77	83	3556	8890	3
B 5	987.77	83	10273	25682	10
B 5	987.77	83	13829	34572	14
C 6	1046.50	84	3349	8372	3
C 6	1046.50	84	15070	37674	14
Db6	1108.73	85	4878	12196	4
Db6	1108.73	85	13305	33262	12
D 6	1174.66	86	4229	10572	3
D 6	1174.66	86	12686	31716	10
Eb6	1244.51	87	3982	9956	3
Eb6	1244.51	87	13938	34846	11
E 6	1318.51	88	4219	10548	3
E 6	1318.51	88	14240	35600	10
F 6	1396.91	89	6146	15366	4
F 6	1396.91	89	13410	33526	9
Gb6	1479.98	90	3552	8880	2
Gb6	1479.98	90	11840	29600	8
G 6	1567.98	91	3136	7840	2
G 6	1567.98	91	12544	31360	8
Ab6	1661.22	92	11961	29902	7
A6	NO MATCHING RATE				
Bb6	1864.65	94	4475	11188	2
Bb6	1864.65	94	13426	33564	7
B 6	1975.33	95	4741	11852	2
B 6	1975.33	95	14222	35556	7
C 7	2093.00	96	5023	12558	2
C 7	2093.00	96	15070	37674	7
Db7	2217.46	97	13305	33262	6
D 7	2349.32	98	5638	14096	2
D 7	2349.32	98	14096	35240	6
Eb7	2489.02	99	5974	14934	2
Eb7	2489.02	99	13938	34846	5
E 7	2637.02	100	6329	15822	2
E 7	2637.02	100	12658	31644	4
F 7	2793.83	101	12293	30732	4
Gb7	2959.95	102	5920	14800	2
Gb7	2959.95	102	11840	29600	4
G 7	3135.96	103	6272	15680	2
G 7	3135.96	103	12544	31360	4
Ab7	3322.44	104	11961	29902	3
Ab7	3322.44	104	15948	39869	4
A7	NO MATCHING RATE				
Bb7	3729.31	106	8950	22376	2
Bb7	3729.31	106	13426	33564	3
B 7	3951.07	107	9483	23706	2
B 7	3951.07	107	14224	35560	3
C 8	4186.01	108	5023	12558	1
C 8	4186.01	108	10046	25116	2
C 8	4186.01	108	15070	37674	3

Fig. 2 *Bandwidth-to-Sample Rate Converter and Optimizer Chart*

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or get the program, enter the sample's actual frequency into the program, and run it just for that frequency.

To use the table with the just intonation scale or random values, it would only be necessary to replace the values in the table with the appropriate new frequencies.

This should clear up some of the confusion about sample rates and input frequencies on the Akai S900. It's a beautiful tool for the beginner as well as the experienced electronic musician looking to add really high-quality samples or *musique concrete* capabilities to a system.

(Note: A copy of the full 50-page printout from the program is available for $15. The program listing is available now for IBM PC and will be soon for the Mac. Each listing goes for $10. Send check or money order only, please, to: The Soundsmith, 1576 Kenneth St., Seaside, CA 93955; Attn.: David Kempton.) EM

Output Oddities of the Akai S900

In the course of my research for this piece—always looking to push my S900 to its limits—I found some interesting and undocumented functions in its output section.

If you connect all 11 of the S900's outputs (eight mono outs, a Left and a Right Stereo out and one "MIX" out) to independent console channels, hoping to get simultaneous, multi-timbral output, you may be surprised. It will seem at first as though the output assignment you've set up is being ignored, and sounds are just winging their way through any handy output. Experimenting further with keygroup assignments and observing the results will show the following (undocumented, though confirmed by an Akai service tech) output assignment:

1. All sounds go out the MIX output (as would be expected).
2. Sounds assigned to outputs one through four also appear at the Left output.
3. Sounds assigned to outputs five through eight also appear at the Right output.
4. Sounds assigned to outputs one through eight are MONOPHONIC (only one note at a time may be heard, even through the Left/Right outputs).
5. Sounds assigned to the Left output (output nine) appear quasi-randomly at outputs one through four. That is, the first note goes out channel one, and succeeding notes make a good try at following a lowest output priority assignment. It appears that:
- If channel one is in use (including completing a decay cycle), the next note goes to channel two.
- If channel two is in use, the note will go to three, even if channel one has become available.
- If channel four is in use, the note will try channels one to three, and if none are available, the note will not play.

6. Sounds assigned to the Right output (ten) appear quasi-randomly at outputs five through eight (see above).
7. Sounds assigned to outputs nine or ten can play a maximum of four notes at a time.

What all this amounts to is that the following assignments are all reliable, and the only recommended way to set up the instrument for multitimbral output.

1. Any system with all keygroups set to output zero will play up to eight polyphonic voices through the MIX output. This is the only reliable way to get more than four-part harmony.
2. Assign a polyphonic (up to four-voice) part through the Left output (nine), and from one to four monophonic keygroups through outputs five to eight. Ignore the MIX output and mono outs one to four.
3. Ditto through the Right out (number ten), and mono outs one to four. Ignore MIX output and outputs five through eight.
4. Assign two different four-part polyphonic voices to the Left and Right outputs. Ignore MIX output and outputs one to eight.
5. Assign up to eight monophonic keygroups through individual outs one to eight. Ignore the Left and Right outputs, and the MIX out.

—D.K.

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Sampling Time-Varying Waveforms

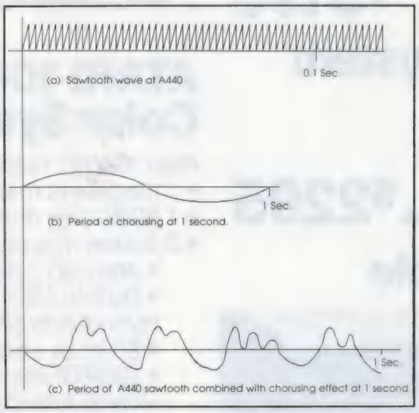
BY WALTER DANIEL

Sampling synthesizers and other keyboards is a valuable technique for anyone who uses a digital sampler (see "Sampanalog Synthesis," May '86 EM). Unfortunately, some of these sounds are difficult to sample effectively—ever tried to sample a non-static waveform that varies over time, and still have memory left when you're done? Still, why take signal processors with you on stage when you can just sample the *processed* sound you want in the first place? And why not put that nice, old-fashioned pulse-width modulation sound into your new digital sampler?

TIME-VARYING WAVEFORMS

Of the many types of waveforms that vary over time, *pulse-width modulation* (PWM), created by modulating an oscillator's pulse-width with an LFO, is probably most familiar to analog synthesists. Also, effects such as flanging and phasing can alter a wave's harmonic content, and hence shape, over time. Even the chorusing of detuned oscillators creates a periodic "beating" of the two frequencies.

This means processed waves repeat themselves *less* often than simple synth waves, so their loop points occur less frequently. **Fig. 1** shows the difference between a standard synthesizer sawtooth wave at A440 and the same wave processed through a phaser modulating once every 0.5 seconds. You only need *one* of the sawtooth periods (1/440th of a second) to create a loop point, but the phased sawtooth has to go through a *number* of periods before it looks like it did at its beginning and therefore offers a good loop point.



(a) Sawtooth wave at A440

(b) Period of chorusing at 1 second.

(c) Period of A440 sawtooth combined with chorusing effect at 1 second.

Fig. 1 *Effect of chorusing on a sawtooth wave.*

THE SOLUTION

The solution is to make the sample's *loop time* identical to the period (time) of the modulating wave's variance. (This period is the reciprocal of the frequency of the variance.) With many samplers, the parameters of sample rate and sample time can be altered, but I usually prefer to use the maximum sampling rate to capture as much of the high frequency content as possible. Incidentally, note that this method applies only to sounds with *one* type of waveform variance. For example, if you're using an outboard effect such as flanging, use a *single* oscillator; adding a detuned second oscillator greatly complicates matters by adding a second frequency variance.

At the synth end of things, the LFO controls the frequency of the waveform variance. If an analog synthesizer's square wave output is processed with a flanger or other outboard unit, the square wave itself is static, but the flanger has a control that sets the rate of its sweep, and hence, the frequency of the waveform variance. You may find no markings as to the number of cycles per second on the panel of an effects device. If so, determine the period of the waveform variance by timing ten cycles of the sweep, then dividing that time by ten.

PROCEDURE

To match the sample time with the waveform variance period, choose a sample time, then adjust the frequency of the effect or synthesizer LFO to match. If the waveform variance is fixed, determine the variance period, then adjust the sample time to match. In both cases, it is best to set the sample time just a bit longer than the waveform variance period since capturing a few more cycles of the sound provides more choices of loop points. Since the static waveform's frequency will usually be in the hundreds of Hz while the frequency of the variance is often less than 10 Hz, capturing a few extra cycles of the static waveform will not use much memory and is a good precaution. Besides, the excess sample may be truncated after looping in order to free that memory.

After matching the sample time and variance period, sample the sound. Now the loop search begins. I use a visual editing program for the Ensoniq Mirage sampler (see "Making Waves: Visual Editing Basics," July '86 **EM**) with my computer to find loops. I look at the beginning of the sample, then examine the end of the sample for a location where the sampled waveform is identical to that at the beginning. If the sample time and variance period have been matched closely, such a location should be quite near the end of the sample. It sometimes takes a little tweaking to match the times, then a resampling of the waveform, but that in itself is no major problem. I believe that for this application the human eye, rather than any type of automated loop search function, is more adept at finding a good loop splice point. A human can view a plot of two waveforms and judge rather easily whether the two are similar, but an automated loop search may look only for a zero crossing and perhaps a slope match. The computer may find a zero crossing, but this might loop to a waveform not quite the same as at the beginning, and cause a discontinuity in the sound.

Figs. 2 through **5** represent a sawtooth wave processed through a phaser and filtered to prevent aliasing. **Fig. 2** is the plot of the beginning of a sound; I used the Mirage's Rotate Sample function to make the sample wrap around so the zero crossing point would be at the beginning of the sample. The sound in the middle portion of the phaser sweep (**Fig. 3**) is quite different from that at the beginning. Typically, loop endpoint searches would begin around the location represented by **Fig. 4**. The outline of the plot is

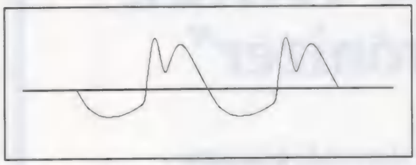


Fig. 2 *Begining portion of a phased sawtooth sound.*

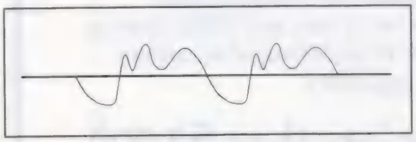


Fig. 3 *Middle portion of the sound.*

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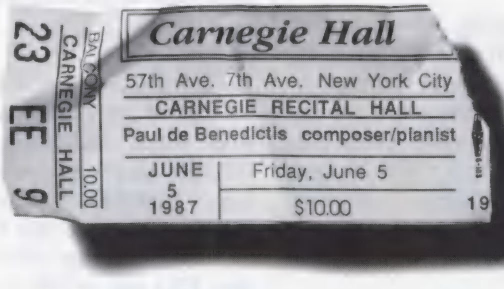
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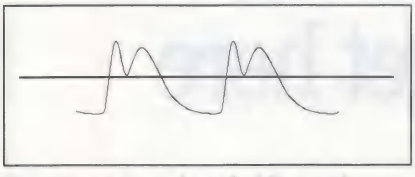


Fig. 4 *Portion near the end of the sound.*

similar to the one in **Fig. 1**, but not close enough to loop; after the waveform in **Fig. 4** rises from negative to positive values, it falls back to momentarily touch the zero level before rising again, but in **Fig. 2**, the waveform does not touch the zero level and remains positive. I searched further along into the sample and was rewarded with a good loop point (**Fig. 5**).

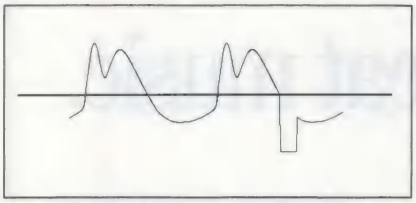


Fig. 5 *Loop end display.*

My visual editing program overlays a grid on the plot to indicate numerical values which helps to decide where the waveform most closely matches the one in **Fig. 2**. The sudden negative jump near the end of the waveform in **Fig. 5** is the loop end marker—from this point, the loop goes back to the beginning (**Fig. 2**).

EXAMPLES

My first illustration of this technique is a sample of an analog synthesizer with pulse-width modulation. I allotted 64K (65,536 bytes) memory with a sampling rate of 30,000 Hz (30 kHz), so the sample time is 65,536/30,000 Hz or 2.18 seconds. To match the pulse-width modulation LFO rate to this, I chose an LFO frequency of 1/2.18 seconds or 0.46 Hz. My synthesizer's frequency control is labeled, so finding this setting was pretty straightforward; with a little LFO tweaking, I found a good loop on my second sample.

The second example is a synthesizer with a fixed 2 Hz chorusing effect. The period of this effect is 1 divided by 2 Hz, or 0.5 seconds. With a sampling rate of 30,000 Hz, the sample memory will be 0.5 seconds × 30,000 Hz, or 15,000 bytes. I set up the parameters as calculated, made the sample, then found a loop point.

For the simple, punch-into-your-calculator formulas:

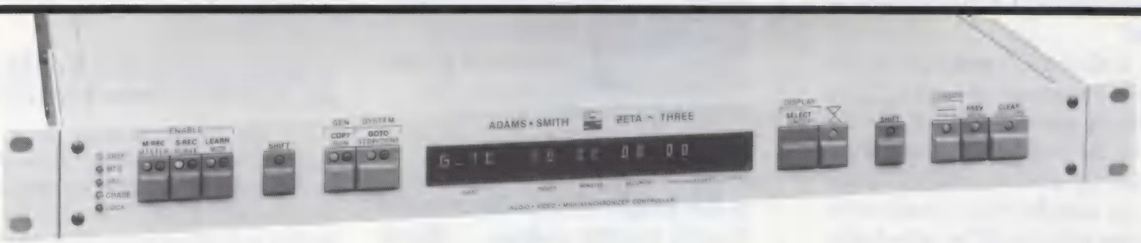
$$\text{Sample size} = \frac{1}{\text{Freq. of mod. effect}} \times \text{Sample rate}$$

which is the same as:

$$\text{Freq. of mod. effect} = \frac{\text{Sample rate}}{\text{Sample size}}$$

THE PROCESSED SOUND

To get a chorused, flanged, or phased timbre out of your sampler, take a simple one-oscillator waveform, process it with an outboard device, then sample the output with this technique. With judicious allocation of memory, one can store several processed sounds in memory at once for instant recall. That sure can simplify



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A MEMORY-SAVING TRICK

I specified a fair amount of memory in the examples mainly so that the numbers would come out nicely. In actual practice, one could use less memory by allocating fewer bytes and sampling at higher pitches, then letting the sampler transpose the signal back down to the desired range. Transposing these kinds of waveforms over large intervals usually does not distort the sounds as with acoustic samples (an effect often referred to as "munchkinization"). For example, I wanted to sample a bass sound with PWM, and have the PWM frequency be around 1 Hz in the two octaves of the keyboard where the sample would be assigned. I sampled a note *higher* in pitch than desired with a PWM frequency of 8 Hz to use less memory, then transposed the sample down two octaves or so. I set up the transposition so that the PWM varied from 0.5 Hz at the lowest note to 2 Hz at the highest, certainly an acceptable range for the sound I was after. Sure, I lost some definition of the sound by using less memory, but for a simple pulse wave it made no significant difference.

> **Any type of periodic time-varying sound can be sampled with this technique.**

CONCLUSIONS

This method has worked really well for me. Any type of periodic time-varying sound (string machines, organs with rotating speakers, you name it) can be sampled with this technique. One of my favorite sounds is a sample of an analog sawtooth wave through a phaser, played with the oscillators of my sampling keyboard detuned—so go add some new sounds to your instrument. **EM**

***Walter Daniel**, full-time student, part-time writer, and sometime musician, does his sampling in Atlanta, Georgia.*

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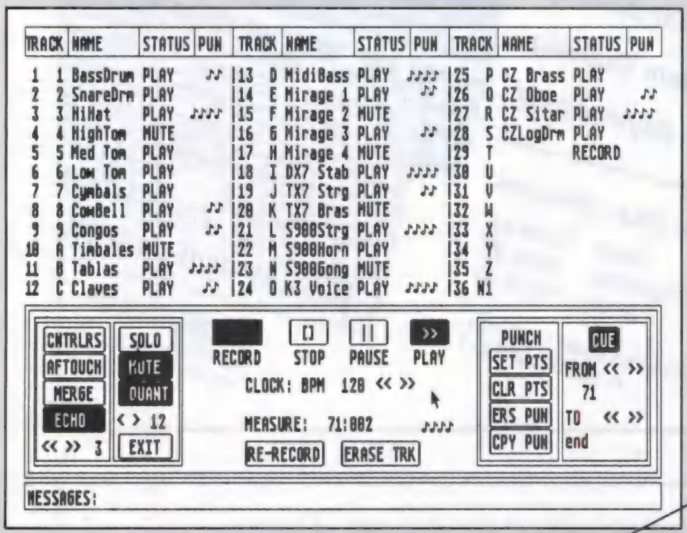

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 2  2 SnareDrm PLAY        |14   E Mirage 1 PLAY    ♪♪ |26  Q CZ Oboe  PLAY     ♪♪
 3  3 HiHat    PLAY   ♪♪♪♪ |15   F Mirage 2 MUTE       |27  R CZ Sitar PLAY   ♪♪♪♪
 4  4 HighTom  MUTE        |16   G Mirage 3 PLAY    ♪♪ |28  S CZLogDrm PLAY
 5  5 Med Tom  PLAY        |17   H Mirage 4 MUTE       |29  T          RECORD
 6  6 Low Tom  PLAY        |18   I DX7 Stab PLAY  ♪♪♪♪ |30  U
 7  7 Cymbals  PLAY        |19   J TX7 Strg PLAY    ♪♪ |31  V
 8  8 CowBell  PLAY     ♪♪ |20   K TX7 Bras MUTE       |32  W
 9  9 Congos   PLAY     ♪♪ |21   L S900Strg PLAY  ♪♪♪♪ |33  X
10  A Timbales MUTE        |22   M S900Horn PLAY       |34  Y
11  B Tablas   PLAY   ♪♪♪♪ |23   N S900Gong MUTE       |35  Z
12  C Claves   PLAY     ♪♪ |24   O K3 Voice PLAY  ♪♪♪♪ |36 N1

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<< >> 3   EXIT         MEASURE:  71:002      ♪♪♪♪      CPY PUN   end
                   RE-RECORD   ERASE TRK
MESSAGES:
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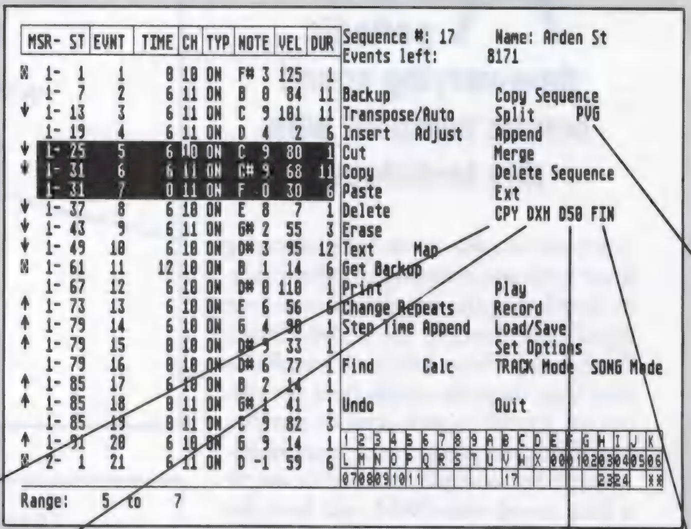

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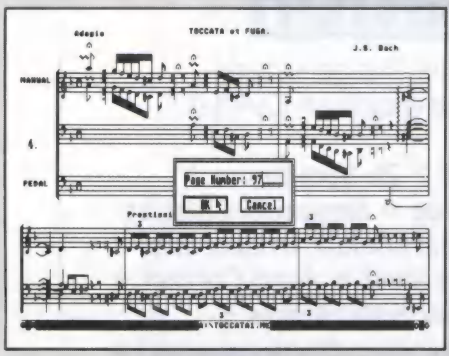
MSR- ST EVNT  TIME CH TYP NOTE   VEL DUR  Sequence #: 17     Name: Arden St
                                          Events left:      8171
   1-  1   1     0 10 ON  F# 3  125   1
   1-  7   2     6 11 ON  B  0   84  11   Backup             Copy Sequence
↓  1- 13   3     6 11 ON  C  9  101  11   Transpose/Auto     Split      PVG
   1- 19   4     6 11 ON  D  4    2   6   Insert   Adjust    Append
↓  1- 25   5     6 10 ON  C  9   80   1   Cut                Merge
↓  1- 31   6     6 11 ON  C# 9   68  11   Copy               Delete Sequence
   1- 31   7     0 11 ON  F  0   30   6   Paste              Ext
↓  1- 37   8     6 10 ON  E  8    7   1   Delete             CPY DXH D50 FIN
↓  1- 43   9     6 11 ON  G# 2   55   3   Erase
↓  1- 49  10     6 10 ON  D# 3   95  12   Text     Map
   1- 61  11    12 10 ON  B  1   14   6   Get Backup
   1- 67  12     6 10 ON  D# 0  110   1   Print              Play
↑  1- 73  13     6 10 ON  E  6   56   6   Change Repeats     Record
↑  1- 79  14     6 10 ON  G  4   90   1   Step Time Append   Load/Save
↑  1- 79  15     0 10 ON  D# 9   33   1                      Set Options
   1- 79  16     0 10 ON  D# 6   77   1   Find     Calc      TRACK Mode  SONG Mode
↑  1- 85  17     6 10 ON  B  2   14   1
↑  1- 85  18     0 11 ON  G# 1   41   1   Undo               Quit
   1- 85  19     0 11 ON  C  9   82   3
↑  1- 91  20     6 10 ON  G  9   14   1   1 2 3 4 5 6 7 8 9 A B C D E F G H I J K
   2-  1  21     6 11 ON  D -1   59   6   L M N O P Q R S T U V W X 00 01 02 03 04 05 06
                                          07 08 09 10 11 17 23 24 XX
Range:    5  to    7
```

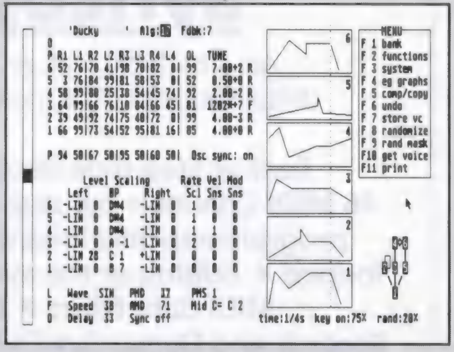
OPEN-MODE EDIT



Adagio
TOCCATA et FUGA.
J.S. Bach
MANUAL
4.
PEDAL
Prestissi
3
OK
Cancel
\TOCCATA1.M

Page Number: 97

COPYIST V1.4



```
'Ducky      '  Alg:17  Fdbk:7
O
P R1 L1 R2 L2 R3 L3 R4 L4  OL   TUNE
6 52 76|70 41|98 70|82  0|  99   7.00+2 R
5  3 76|84 99|81 58|53  0|  52   0.50+0 R
4 58 99|80 25|38 54|45 74|  92   2.00-2 R
3 64 79|66 76|10 84|66 45|  81  1282*+7 F
2 39 49|92 74|75 40|72  0|  99   4.00-3 R
1 66 99|73 54|52 95|81 16|  85   4.00+0 R

P 94 50|67 50|95 50|60 50|  Osc sync: on

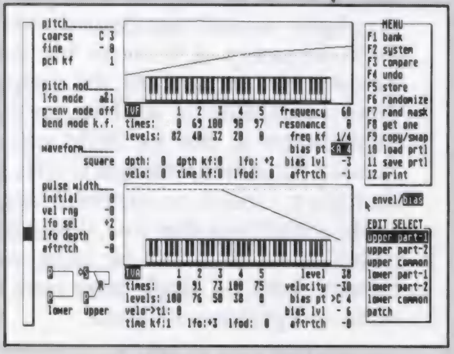
     Level Scaling      Rate Vel Mod
   Left    BP    Right   Scl Sns Sns
6  -LIN  0  DM4  -LIN  0   1   0   0
5  -LIN  0  DM4  -LIN  0   1   0   0
4  -LIN  0  DM4  -LIN  0   1   1   0
3  -LIN  0  A -1 -LIN  0   2   0   0
2  -LIN 20  C 1  +LIN  0   0   0   0
1  -LIN  0  B 7  -LIN  0   0   0   0

L  Wave  SIN   PMD   17   PMS 1
F  Speed  38   AMD   71   Mid C= C 2
O  Delay  33   Sync off

time:1/4s  key on:75%  rand:20%
```

MENU
F 1 bank
F 2 functions
F 3 system
F 4 eg graphs
F 5 comp/copy
F 6 undo
F 7 store vc
F 8 randomize
F 9 rand mask
F10 get voice
F11 print
6
5
4
3
2
1

DX-HEAVEN



```
pitch________
coarse     C 3
fine       - 0
pch kf       1

pitch mod____
lfo mode   a&1
p-env mode off
bend mode k.f.

waveform_____
        square

pulse width__
initial      0
vel rng     -0
lfo sel     +2
lfo depth    0
aftrtch     -0

TVF   1   2   3   4   5   frequency  60
times:    0  69 100  90  97   resonance   0
levels:  82  40  32  20   0     freq kf 1/4
                                bias pt <A 4
dpth: 0  dpth kf:0  lfo: +2   bias lvl   -3
velo: 0  time kf:0  lfod:  0   aftrtch   -1

TVA   1   2   3   4   5       level  38
times:    0  91  73 100  75    velocity -30
levels: 100  76  50  38   0     bias pt >C 4
velo->t1: 0                    bias lvl - 6
time kf:1   lfo:+3  lfod:  0   aftrtch   -0
```

MENU
F1 bank
F2 system
F3 compare
F4 undo
F5 store
F6 randomize
F7 rand mask
F8 get one
F9 copy/swap
10 load prtl
11 save prtl
12 print
envel/bias
EDIT SELECT
upper part-1
upper part-2
upper common
lower part-1
lower part-2
lower common
patch
P
S
R
lower
upper

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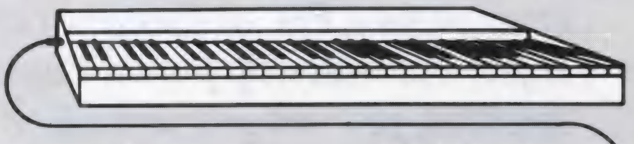

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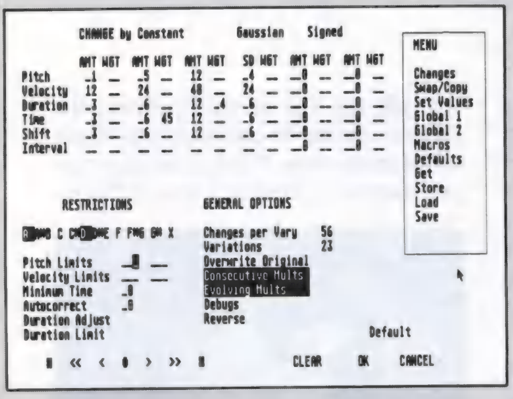

CHANGE by Constant Gaussian Signed

	AMT	WGT	AMT	WGT	AMT	WGT	SD	WGT	AMT	WGT	AMT	WGT
Pitch	_1	_	_5	_	12	_	_4	_	_0	_	_0	_
Velocity	12	_	24	_	48	_	24	_	_0	_	_0	_
Duration	_3	_	_6	_	12	_4	_6	_	_0	_	_0	_
Time	_3	_	_6	45	12	_	_6	_	_0	_	_0	_
Shift	_3	_	_6	_	12	_	_6	_	_0	_	_0	_
Interval	_	_	_	_	_	_	_	_	_0	_	_0	_

RESTRICTIONS

A A#B C C#D D#E F F#G G# X

Pitch Limits _0 _
Velocity Limits _ _
Minimum Time _0
Autocorrect _0
Duration Adjust
Duration Limit

GENERAL OPTIONS

Changes per Vary 56
Variations 23
Overwrite Original
Consecutive Mults
Evolving Mults
Debugs
Reverse

The PVG is also an editing and orchestrating tool of unprecedented power and flexibility. Notes can be selected for editing operations using a wide range of criteria, including pitch, velocity, interval from last note, and position in pattern. Different parts of a phrase pattern or different scale positions can be independently accented, de-accented, or muted completely. Controller values that depend on the pitch, dynamics, or position of a note can be added. Selected notes can be doubled on another channel, echoed, pitch shifted, or turned into simple riffs or chords of ANY type. Swing can be added to a part recorded in straight time, and the amount of swing can vary from measure to measure.

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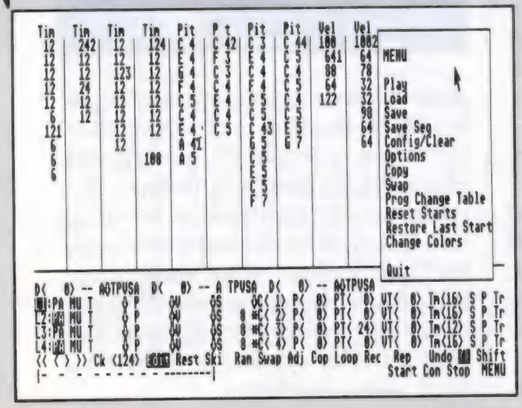

Tim	Tim	Tim	Tim	Pit	P t	Pit	Pit	Vel	Vel
12	242	12	124	C 4	C 42	C 3	C 44	100	1002
12	12	12	12	E 4	F 3	E 4	C 5	641	64
12	12	123	12	G 4	C 3	C 4	C 4	88	78
12	24	12	12	F 4	C 4	F 4	C 5	64	32
12	12	12	12	C 5	E 4	C 5	C 4	122	32
6	12	12	12	C 4	C 4	C 5	C 5		98
121		12	12	E 4	C 5	C 43	E 5		64
6		12		A 41		G 5	G 7		64
6			108	A 5		C 5			
6						E 5			
						C 5			
						F 7			

```
D(   0) -- A0TPUSA  D(   0) -- A TPUSA  D(   0) -- A0TPUSA
L1:PA MU T      0 P      0W      0S     0C( 1) P(  0) PT(  0) VT(  0) Tm(16) S P Tr
L2:PA MU T      0 P      0W      0S   8 *C( 2) P(  0) PT(  0) VT(  0) Tm(16) S P Tr
L3:PA MU T      0 P      0W      0S   8 *C( 3) P(  0) PT( 24) VT(  0) Tm(12) S P Tr
L4:PA MU T      0 P      0W      0S   8 *C( 4) P(  0) PT(  0) VT(  0) Tm(16) S P Tr
<< < > >> Ck (124) Edit Rest Ski  Ran Swap Adj Cop Loop Rec  Rep   Undo    Shift
|- -  -  - - - - - --------|                                Start Con Stop  MENU
```

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Programming FM synthesizers can be confusing at first but with help from a Yamaha product specialist, you can program effects from vocal synthesis to reverb—and have a lot of fun.

The Continually Expanding Universe:

Tips to Tame the DX7II

BY KEVIN STRATTON

As a product specialist with Yamaha, I'm often asked whether programming the DX7II is more difficult than programming the original DX7. The truth of the matter is that most of the new features don't add any more surprises to the elusive "Edit Zone," but do give more of the features we asked for: better MIDI control, alternate tunings, stereo, more memory, better sound quality, and so on (see sidebar).

Contrary to myth, programming the DX7II is not at all impossible for mere mortals. In this article, we'll cover a few of my favorite programming tips, and open the doors to a more realistic approach to achieving the sounds of FM never before heard.

HEARING FUNDAMENTALS—HOW FM CREATES SOUND

Before we can understand FM we must first understand how our ears perceive sound. In looking at how humans hear, we'll see that the DX creates sounds according to these very laws.

In the human hearing process, our ears are sensitive to only two acoustic qualities: *pitch* and *level* (volume). In the DX, most of the parameters will control one of these two qualities. For example, pitch is affected by parameters such as Tune, Ratio, and Fixed; level is affected by the Output, Scaling, and Amplitude parameters. Changing one of these parameters will affect Pitch or Volume accordingly.

No matter what word describes the particular kind of pitch or level change taking place, *any sound editing parameter change is going to represent either a change in pitch or a change in level.* This has always been helpful for me in understanding what is going on inside the DX.

The DX uses "sonic building blocks" called *Operators*. Each Operator (Op. for short) consists of a sine-wave generator (with an associated envelope generator to control the sine-wave generator's output); the Operator can serve as either a *carrier* or a *modulator*. A carrier provides us with an audio output. A modulator injects rapid frequency fluctuations into the carrier, which affects the output and imparts a particular tone color, or *timbre*. Changing either the amplitude or frequency of the modulator affects the timbre of the carrier output.

Multiple Operators (FM instruments typically use four or six Operators; the DX uses six) can be combined into what's called an *algorithm*. Think of the algorithm as a number of vertical stacks of Opera-

***Kevin Stratton** is currently a product specialist with Yamaha Music Corp.'s Digital Musical Instrument Division. Founder of the first Electronic Musician's Group in Illinois, Kevin has done a great deal of research involving both vocal synthesis and reverberation using FM Digital Synthesis. He has developed original software programs, performed and produced music for television using the YCAMS system, and has appeared in concerts and clinics across the country.*

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tors. Carriers, the Operators at the bottom of the algorithm (**Fig. 1**), have their outputs mixed together to provide the audio output and constitute the fundamentals of our sound. Modulators are stacked vertically on top of the carriers, or on top of other modulators. In **Fig. 1**, Operators 1 and 3 are carriers. Op. 1 is modulated by Op. 2, and Op. 3 is modulated by Operators 4 *and* 5. In addition, Op. 5 is being modulated by Op. 6. (That line around Op. 2 indicates a feedback path, yet another way to create timbral changes.)

Now let's consider what happens when we change the frequency of the carrier or modulator. Changing the *carrier's* frequency will change the perceived pitch of the sound. Changing the *modulator's* frequency doesn't change the perceived pitch, but does change the harmonics that will be emphasized. Regard-

Yamaha DX7IID Mini-Review

BY DON SLEPIAN

The DX7IID is Yamaha's update to the popular DX7 digital synth. (Another model, the DX7IIFD, includes an on-board disk drive for patch and MIDI data storage; however, the DX7IID can use Yamaha's MDF1 external disk drive to provide similar capabilities.) The DX7IID incorporates many of the most popular features of the enhancement kits offered for the DX7 (micro-tuning capabilities, extra memory) and then makes some significant departures (such as dual/split modes and panning). It still, however, maintains compatibility with existing voice libraries. All in all, in the time that I've had my DX7IID it has become one of my favorite keyboards.

For me the DX7IID was like finding a long lost friend. During 1980 I left Bell Labs (where I had been voicing their real time digital synthesizer, the "Alles machine") to spend a week, at Yamaha's invitation, at their research and development center. I was to voice one of Yamaha's earliest digital synths, the GS-1—which weighed over 200 lbs., had a $16,000 price tag, and offered no user programming (I worked with a separate programming device). I remember the GS-1 as having a single fixed algorithm consisting of six FM triplets, a total of 18 operators split symmetrically (nine per channel in stereo). Its system clock ran at 67 kHz, and I fell in love with the clean, detailed, glorious stereo sound.

I was sorely disappointed by the original DX7 because I felt it didn't uphold this high sonic standard. Yamaha seems to downplay the improvement in sound in their new line yet I find the difference so remarkable that I wish they had given the DX7IID a new name. They took what I perceived as the thin, flat, mono sound of a DX7 and gave me back the clear, clean, true stereo sound I thought had been lost forever with the GS-1. It's like switching from a cassette deck to a CD player—not a subtle evolution, but a clear and obvious departure in sound quality.

The DX7IID is also very performance-oriented. Both internal and cartridge memories are doubled, and a whole new set of powerful playing combinations called *Performance Memories* are now available. Features such as *two independent* eight-voice tone generators, sophisticated stereo and pan features, and a backlit LCD display make the machine more versatile and convenient.

So what is there to criticize? Certainly not the price or value of the instrument. However, those who expect to use the unit "right out of the box" may be disappointed, since I feel that the performance presets of the instrument as shipped are designed to best display the DX7II's versatility in the context of a sales demo in a store, and are not designed with any particular musical application in mind. Don't let this put you off, though; the performance presets are all editable, and taking the effort to program presets that fit your music will be time well spent.

I found it best to always leave the instrument's volume control on full and control my level at the mixer; when the volume slider is set to less than full, the digital noise level rises noticeably. Also, the LFO-driven pan function is noisier than it should be, so I tend not to use it. I feel the mechanical design is not at the same level of excellence as the electronics; my unit arrived with one broken key, and I had to do a fair bit of disassembly to remove the keyboard. (*Editor's note: we asked Yamaha about this; according to a company spokesman, "all he had to do was to take it back to the dealer he bought it from, or any other authorized Yamaha DMI retailer, for a quick, free fix." Unless you are extremely pressed for time—e.g., you have a gig that night—and are a competent technician, we advise leaving servicing to authorized service centers, especially if the unit is under warranty.*) For professional use, a detached-style power cord is essential—the standard integral power cord is too vulnerable to damage during cartage. And I'd love software control over the pedal and footswitch connections so one could use Japanese-style normally closed-circuit accessories as well as the American and European normally open-circuit types.

Overall, however, I can enthusiastically recommend the instrument. I suggest buying a good case with the instrument, and having a detachable power cord installed by an authorized repair shop. Like all these new instruments, a few hours working at the keyboard with the manual in hand really pays off, since many functions and features are neither intuitive nor obvious. Try doing some voice editing, and get clear on the difference between voice and performance editing. Features such as aftertouch and parameter changing sliders take some practice to master, but are well worth the effort.

I would happily take the DX7IID over most any other electronic keyboard . . . now it's time to think about adding a TX802 as an expander.

ing level, increasing the *carrier's* level increases the overall level of that Operator or stack of Operators. Increasing the *modulator's* level increases the amount of Frequency Modulation that takes place, and therefore increases the *amount* of harmonics (also known as sidebands) produced by the carrier. These are really the only major rules of thumb you need to know when forming a sound on the DX. There's a good reason why the algorithms are printed on the DX panel; they give you an idea of how the sound is constructed, not unlike the block diagram for an electronic circuit.

FOUR BASIC FOOD GROUPS, FIVE BASIC WAVEFORMS

Let's go back for just a moment to the years when giant subtractive modular synthesizers roamed the earth, in the days of Voltage Controlled Oscillators and Filters. In those days, tweaking the knob of a filter or changing the waveform of an oscillator gave us timbral changes. Today, we can still obtain these kinds of sounds with ease, and this is a good place to begin your experiments in FM programming.

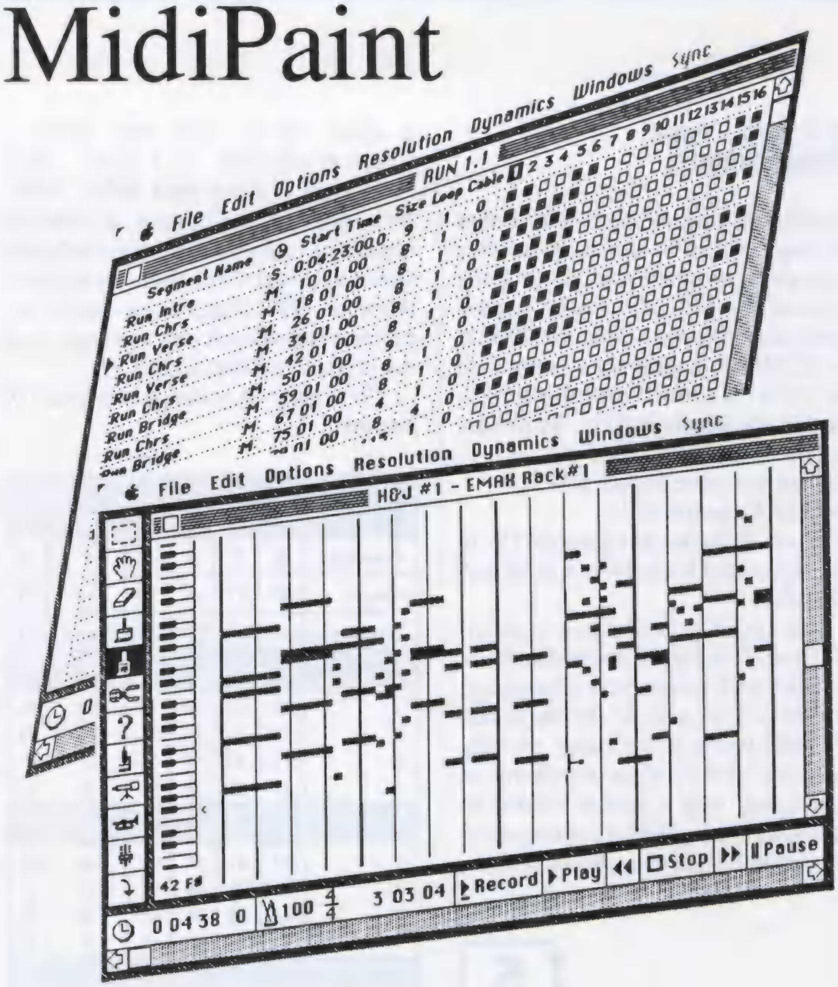
In creating the five basic waveforms (sine, triangle, sawtooth, square, and noise), the only components needed are a single carrier and a modulator stacked right above the carrier. By placing the DX into *initialize voice*, you are ready to go; here's the "template" from which we can create the five basic waveforms.

Algorithm : 1
Feedback : Z
Operator 1 (carrier) output level : 99
Operator 2 (modulator) output level : XX
Operator 1 frequency ratio : 1.00
Operator 2 frequency ratio : Y.YY

Now all we have to do is plug different numbers into Z, XX, and Y.YY according to the following table:

Waveform	XX value	Y.YY value	Z value
Sine	40 or lower	Any value	0
Triangle	40 to 70	1.00	0
FM Sawtooth	70 or higher	1.00	Any value
Square	40 or higher	2.00, 3.00 5.00, etc.	0
Noise	93 or higher	Any value	7

MidiPaint



MidiPaint is a sophisticated, high performance professional sequencer for the Apple Macintosh. It's designed to bring you the full power of the Macintosh II, and Apple's new MultiFinder multi-tasking operating system. When used with our JamBox/4 MIDI Processor, MidiPaint provides the most accurate timing and SMPTE lock of any sequencer you can buy.

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THE PSEUDO-TX81Z SAWTOOTH TRICK

Note that the third waveform is labeled as "FM Sawtooth"; this is because *another* sawtooth exists inside the DX—not one generated by FM, but actually, a pure digital sawtooth wave. Like the TX81Z, the DX7II has a different waveform to add to the FM process, and this wave is found in the Feedback loop. Try this for yourself:

1. Initialize a voice in your DX.
2. Set the Algorithm to 32.
3. Turn off all Operators except for Op. 6.
4. Set the output level of Op. 6 to 99 and feedback to 7.

This sound is unlike any standard FM sound. Thinking of the feedback as a separate waveform can be very helpful on Algorithms 4, 6, and 32. Try them out, and while you're at it, change the Key Mode (button #23) from polyphonic to Unison Poly with a unison detune of your choice. Thoughtful use of this waveform can embellish and thicken sounds.

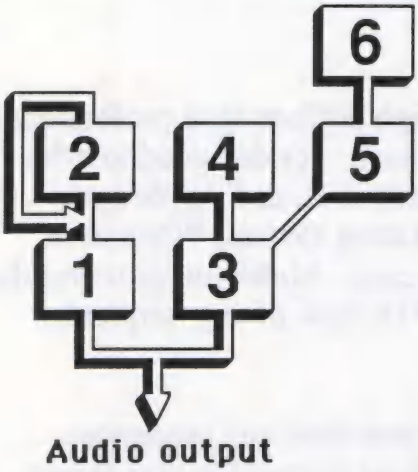


Fig. 1 *Algorithm 9 for the DX7II (and other six-operator synthesizers)*

FM REVERB

In more complex FM configurations, where there is more than one modulator, all the above rules still apply. The versatility of a complex stack can even help place your sounds in an *environment*, so get ready to extend your sound into space as well as time.

First, let's look at two effects that play a big role in the ambience component of a sound: *diffusion* and *delay*. When a sound reverberates in a room, waves bounce off of every hard surface there, and return to the listener at different times. The final effect causes the reflected waves to cancel themselves out at different times. This happens so quickly we perceive the delayed part as a shadow of the original or direct sound.

To see this in action set up your DX like this:

Algorithm = 9 Feedback = 7						
Operators	**1**	**2**	**3**	**4**	**5**	**6**
Output	99	77	98	77	84	85
Frequency	2.00	2.00	2.00	2.00	Fixed*	2.00
Envelope Rates						
1	58	48	50	42	50	50
2	52	32	75	30	75	75
3	11	20	10	15	10	10
4	57	46	39	58	8	0
Levels						
1	99	95	99	95	99	99
2	95	95	94	97	96	0
3	33	84	35	85	38	36
4	0	0	0	0	0	0
Velocity						
	3	3	3	4	2	2
*Note: Op. 5 is in Fixed mode and can have a Frequency from 1.000 to 2.884.						

We have yet to talk about envelopes generators, but bear with me and just enter the numbers as shown.

If you look at Algorithm 9 (**Fig. 1**) you will notice that there are two basic stacks; Operators 1 and 2, and Operators 3, 4, 5, and 6. The first stack (1 and 2) provides a basic FM sawtooth, with the modulator's envelope acting like the envelope of a filter as it varies the effect of the modulator on the carrier. This creates a simple brass voice. The second stack (3, 4, 5, and 6) contains an identical frequency ratio between Op. 3 and Op. 6, with a fixed frequency sandwiched in between. The fixed frequency causes the harmonics generated by the 1:1 ratio (Op. 3 and 6) to wash out, thus leaving a mirrored, diffused version of the first stack that works well to create our "ambience." Envelope generators in the second stack create the exact types of delay properties desired. For example, you can change Rate 4 of Op. 3 to lengthen or shorten the reverb time, and change the Fine Frequency of Op. 5 to alter the pre-delay. With a little time and effort, you'll be adding reverb to any waveform you like.

FM WAVETABLE SYNTHESIS: THE HUMAN VOICE

A *wavetable* is nothing more than a specific waveform(s) that precisely duplicates a sampled or acoustic event. So far we have seen how to create basic waveforms, which can be considered wavetables in their own right. What we're about to cover forms the foundation of an acoustic sound—the human voice. This particular sound, as most programmers agree, is one of the most difficult to master and always sounds different to the next listener. The wavetable of this sound is not a patch, but a structured foundation with which to begin your own patch.

The vocal wavetable requires a minimum of two Operators, and a maximum of three Operators if you desire a broader bandwidth. First let's start by initializing voice, selecting Algorithm 3 (**Fig. 2**), and shutting off Operators 4, 5, and 6. Next, raise the output level of Op. 1 to 99 and the output of Op. 2 to 87. Set the frequency ratio to 2:1 (in other words, the carrier, Op. 1, to 2.00 and the modulator, Op. 2, to 1.00). This creates the resonance of the throat. By adding a Pitch Modulation sensitivity of 2 and Pitch Modulation depth of 9, and selecting a triangle wave LFO in multi-LFO mode with a speed of 29, we add movement to this static wave-

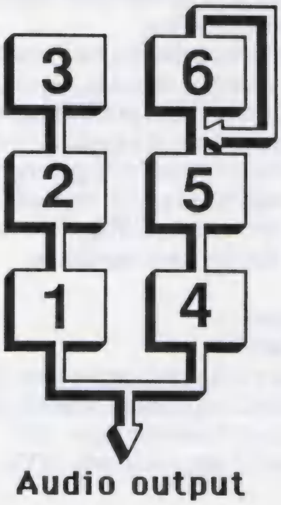
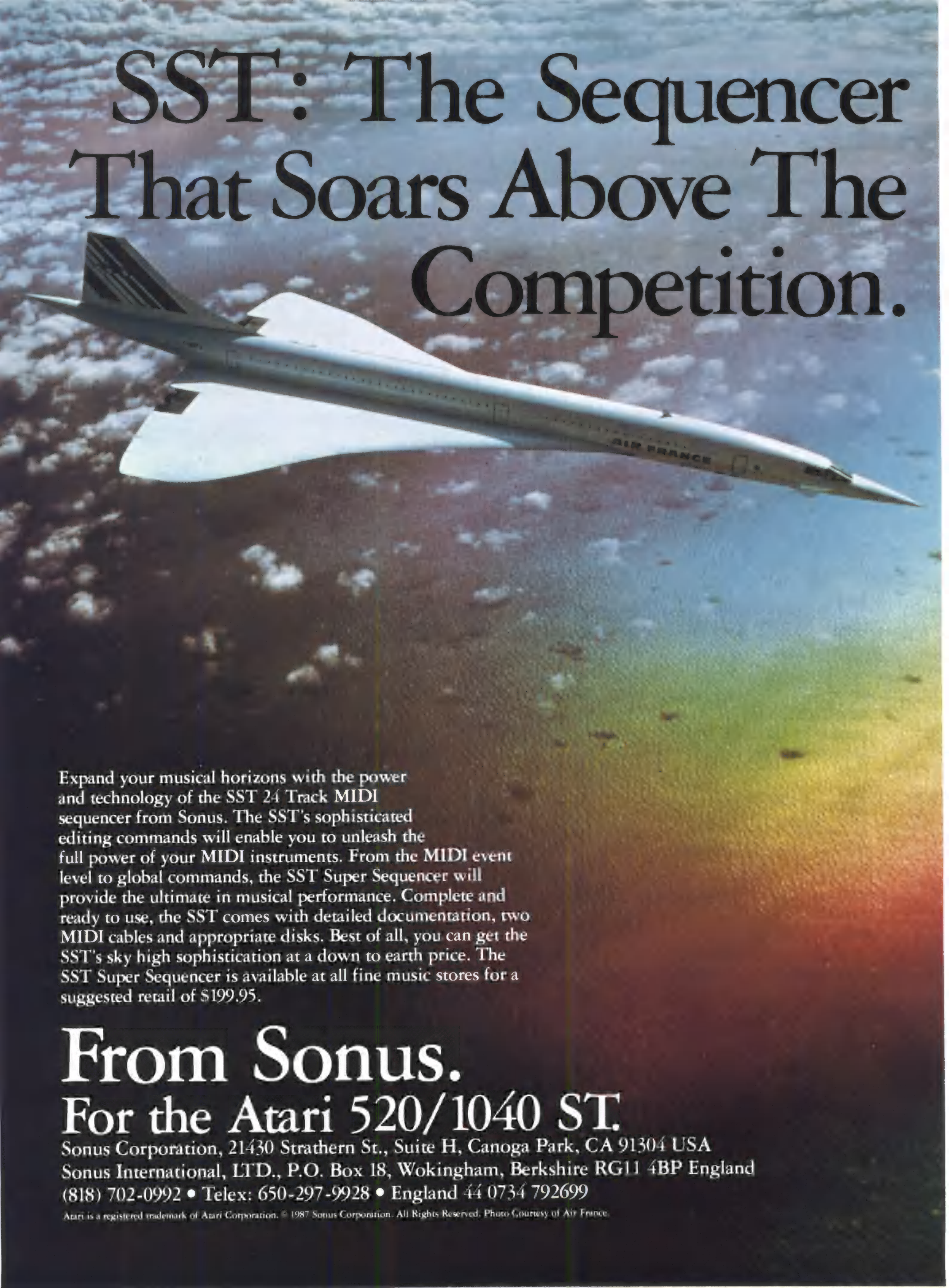


Fig. 2 *Algorithm 3 for the DX7II (and other six-operator synthesizers)*



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form. Movement becomes a very important factor because the human voice has the unique quality of changing harmonic content without altering the pitch (this is known as Chroma Shift). The best way to create this Chroma Shift is by putting the Key Mode to Unison Poly with a detune of 6. Now add in Op. 3 at an output level of 44 and a frequency ratio of 6:10; this gives the voice its nasal resonances. From here, working with the envelopes of the modulators can give the voice different pronunciations, while changing Op. 3's fine frequency produces different voice qualities and bandwidths.

FUN WITH FRACTIONS

Fractional Scaling, a new feature of the DX family, allows control of the volume (or output level) of each Operator every three keys on the keyboard. Notice that the range of the output level is extended from the original 0 through 99 to 0 through 255 on the DX7II—this certainly lets you control those small differences "between the cracks." Think back about what changes in modulator output do to the sound, and imagine what fractional scaling can do to give you truly tight control over the harmonic content in a sound (i.e. the cracks become canyons, or mole hills turn into mountains, depending on what kind of fanciful constructions you want to create). Try experimenting with different volume levels for the modulators across the keyboard; see if you can take the vocal wavetable and develop areas on the keyboard that make independent bass, tenor, alto, and soprano sections.

CARRIER ME AWAY...

Well, it's hard to believe, but I'm just as long-winded on my word processor as I can be in a clinic. Still, there are many more features found on the DX7II that call out for recognition: micro-tuning, dual and split modes, panning, and so on. But for now we are out of time and space. Oh no! Time for me to get my daily dose of "Green Screen" (Yamaha Specialist jargon for programming time!).

One last bit of advice on programming the new DX7II: be a leader, not a follower. In these days, where the sound is your signature, sign your own name and dare to dwell on the edge. After all, "Why be Normal?" EM

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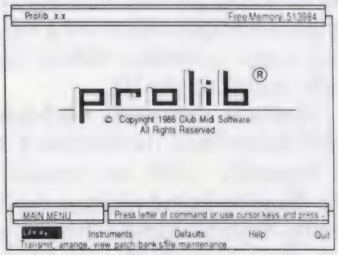

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Club Midi

Got some questions about the Oberheim DX/DMX, Prophet-5, Chroma, or Polaris? Here are some answers.

Questions & Answers

BY ALAN GARY CAMPBELL

Q. *I want to add a MIDI In port to my Oberheim DX/Stretch drum machine (it already has a MIDI Out clock). Who does this mod?*

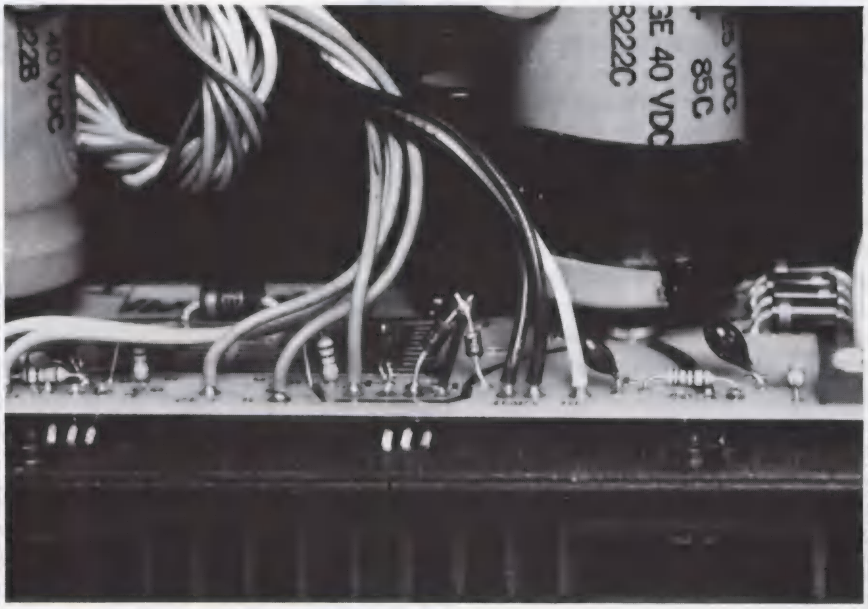
Q. *Is there a MIDI retrofit available for the DMX drum machine?*

A. Newer models of the DX have a MIDI In. The Stretch option has a MIDI Out, solely for sending MIDI clock data. There is apparently no retrofit for older DXs; and since they provide no analog trigger inputs, it is impossible to use a MIDI-to-drum-trigger converter without significantly modifying the DX.

Oberheim does make a full-featured retrofit for the DMX, the *DMX MIDI/Memory Expansion* ($299 less installation). This daughter board replaces the Rev 3 memory expansion board in newer units, and adds the memory expansion and MIDI features to older units. It allows the DMX to send/receive MIDI clock data, play its sounds via MIDI, send/receive Sys Ex dumps, etc., and comes with complete documentation. It includes a new right end-bell with premounted MIDI In and Out jacks, which simplifies installation—the only hard part being a tricky trace-cut/tack-solder procedure at the rear of the Processor Board.

Q. *I had my Rev 3.2 Prophet-5 upgraded with the SCI MIDI retrofit at a local service center. The unit now occasionally "locks up," mostly at random, but more often after it's been on for a while. The service center couldn't duplicate the problem, and they say it's a common symptom for MIDI'd Prophets. Is there a cure?*

A. The Prophet MIDI retrofit demands increased current from the +5 Volt digital supply. The supply design "floats" its 7805-regulator ground via a diode, producing an output voltage of +5.6 volts, to allow some headroom (a series diode on the CPU board drops this back to 5 Volts); in some cases, with component aging and high ambient temperatures, the supply voltage dips below acceptable levels, and the instrument locks up.



PROPHET-5 COURTESY OF TAYLOR CALDWELL

PHOTO: BILL KINNAMAN

Fig. 1 *Prophet-5 Power Supply Mod*

The solution to the problem is to add an additional diode on the power supply board, in series with the existing one. This can be done without disassembling the power supply as follows: unplug the instrument, and remove the bottom panel (refer to the *Prophet-5 Technical Manual*); disconnect the power supply, audio and MIDI cables. Locate the 1N4002 diode (D505) at the center of the power supply board, just behind the solder pads for the 7805 regulator. Desolder the *left* diode lead only; use a small (about 30 Watt) soldering iron with a petite tip, and pry up the lead with a miniature flat-blade screwdriver. Do not leave the tip in contact with the lead and

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***Alan Gary Campbell** is owner of Musitech,™ a consulting firm specializing in electronic music product design.*

solder pad any longer than you have to; but also do not pull up on the lead until the solder flows, or you might tear the pad away from the board. Take care not to let the iron slip and damage any of the nearby cables. Bend the diode up at about a 70 degree angle, and straighten out the desoldered lead.

Prepare a 1N4002 diode (a 1N4003 Radio Shack catalog number 276-1102 is an acceptable substitute), clean the leads, and cut the anode lead (unbanded end) to a length of about ⅜-inch (9.5 mm). Install the new diode at the desoldered location, oriented as shown in **Fig. 1**, with the cathode (banded end) up. Again, make sure the solder flows before you push the lead through the hole, or you might damage the pad *underneath* the board; and add a bit of new solder to insure a good joint. Solder the unconnected leads of the two diodes together, and trim any excess lead length. Before re-assembly, use an Ohmmeter to check for continuity between the anode of the new diode and the center pin of the regulator. Visually inspect the underside of the board to be sure the newly installed diode lead does not protrude too far under the board and is not in contact with any of the regulator leads. SCI technician Andrew McGowan advises that this mod should be installed on all MIDI'd Prophets, though it is not mentioned in the MIDI retrofit Installation Manual.

The Prophet can also lock up from less common types of power supply and CPU problems. If the diode mod doesn't fix your glitch, test the power supply under load, and check the clock, battery back-up, and reset circuits. If at all possible, obtain a cassette save of the Prophet's programs before you proceed—if the "disease" doesn't dump them, the cure probably will. If you have to replace the 74C02 (IC 309) in the reset circuit, note that it goes on the board *backwards* relative to the other logic chips nearby.

Q. *I have a Rhodes Chroma that I really love—especially the keyboard action—except for one thing. The weights on the key mechanisms keep coming loose, causing keys to jam. I don't think I play the instrument that hard. Is there any way to fix this?*

Q. *I just purchased a mint condition Chroma. It doesn't have MIDI, but it does have the "Chroma" interface. Can I use this with my Fender Polaris, which has a similar interface? Where can I get the correct cable, or add*

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MIDI to it? Also, I can't get the cassette interface to work, no matter what I try.

A. To fix loose keyweights, align any loose weights and tighten—not *overtighten*—all their screws. Apply a small amount of silicon sealer (Radio Shack catalog number 64-2314) to the front edge of each weight, and the screws. Let cure for 24 hours before playing the instrument.

You *can* hook the Chroma and Polaris together via the Chroma Parallel Interface if you set the Polaris transmission parameters correctly (see the Owner's Manual). Since the architectures differ, not all features will work bi-directionally.

The main advantage in using the Chroma Interface is *speed.* It's much faster than MIDI. With it, you can control the Chroma synthesizer from the Polaris internal sequencer; and you can use the Polaris MIDI ports simultaneously. Unfortunately, you can't send data input through the Chroma Interface back out over the Polaris MIDI.

You can also use the Chroma Interface to connect either instrument to Fender's Computer Interface card for the Apple II, but there is very little software that is compatible with it; unless you could find one at a bargain price, and you already own an Apple or compatible, you probably wouldn't want to use this scheme. (Note: the *Chroma/Chroma Polaris Computer Interface Manual* is available at no charge from Fender Musical Instruments, 1300 East Valencia Drive, Fullerton, CA 92631.)

The Chroma Interface, though parallel, uses a standard female DB25 connector, like many RS232 serial computer ports; but you can't use just any old cable. Some of the pins are wired one-to-one, but the data input lines on one unit connect to the output lines on the other, and vice versa. Fender makes a suitable cable, called simply the *Computer Interface Cable,* part number 30-5711201 ($71.50). It's expensive, but it's a quality six-foot, shielded, molded cable that meets FCC specs. You might be able to get it for less if you order through a service center.

Regarding the cassette interface, check your instrument's serial number: Chroma synthesizers 0011-0151 (approximately) require a hardware update to the cassette circuit. See Technical Service Bulletin number FCN2-002, free from Fender. The mod involves adding a bypass cap on the I/O Board, and cutting a trace and adding a resistor on the CPU Board (refer to a Chroma service manual).

Note that cassette interface malfunctions are almost always caused by recorder, tape, or cable problems or incompatibilities; a hardware malfunction in the synth will usually affect either the cassette input or output, but not both. If the update described above has been installed, but the input isn't working, test and/or replace C11 and ICs Z8 and Z10 (on the I/O Board); if the output isn't working, test and/or replace C5 and Z29.

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Cassette interface malfunctions are almost always caused by recorder, tape, or cable problems or incompatibilities.

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To add MIDI to a Chroma synthesizer, you need a Chroma-to-MIDI interface converter, an external device that connects to (and uses up) the Chroma Interface. J L Cooper offers the *MIDI Chromaface* ($350), but will phase it out soon. Chroma Cult offers the *Chroma to MIDI Converter* ($300) with complete MIDI implementation, lots of features (including multi-timbral operation and programmable setups), and compatibility with the Fender computer interface. Chroma Cult also offers a Chroma *4X* memory expander and a breath-controller input mod. Order direct, or through dealers. Write: Chroma Cult Headquarters, 4378 Avenida Prado, Thousand Oaks, CA 91360.

Polaris Rev 9 ROMs (Jan '87 *Service Clinic*) inadvertently produce a problem: playing softly will not trigger the instrument. *Rev 9A* alleviates the problem while retaining all other features. Fender Authorized Service Centers can get a free master set of Rev 9A EPROM "templates" for making copies to install at a locally determined price.

Chroma Rev 14 has a similar keyboard response problem. Software update "14A" fixes that and is available to Authorized Service Centers at no charge.

The *Chroma Polaris MIDI Implementation Manual* is available free from Fender. Opcode (444 Ramona, Palo Alto, CA 94301 ☎ 415 / 321-8977) is the only company I know making a librarian for the Chroma and/or Polaris.

NOTES

"Version 2" of the Wersi M88 ROM, (July '87 *Service Clinic*) changes the keyboard's response to MIDI velocity and swaps the channel assignment in split mode. Some Version 1 M88s don't match either Version 1 *or* 2. Since Wersi's Lancaster office is unaware of this factory substitute, I sent them copies of the ROMs to test; if your M88 doesn't feel like the one in the store, have a service center check the ROM version.

CZ owners are having problems with adapter plugs (including the Radio Shack 277-1026 adapters I recommended); the CZ-230S in particular is reported to have a relatively high incidence of DC power jack failure. This is the same jack used in the CZ-101 and CZ-1000, but the problems seem to be limited to CZ-230S units.

To test a CZ-230S power jack, remove the batteries and power up the synth with just the adapter (use a Casio AD-5 adapter for the test, to insure that the plug has the correct size and geometry). If it doesn't come on, or if wiggling the plug causes the power to cut out, then replace the jack. Refer in-warranty units to a Casio Authorized Service Center; but it's a fairly easy repair job. The jacks are on a separate board in the 230S, so there's no need to remove the main boards to get to them. The replacement jack (Casio part HEC0470-01-270) can be ordered through a service center.

Our final note is that the pioneer synthesizer manufacturer Moog Electronics has gone out of business. Its assets have been purchased by EJE Research Corporation, who has plans to continue Moog's recent endeavors in subcontract manufacturing and perhaps electronic musical instrument products. The facilities and address have not changed. Service Manager Bob Hackett reports that parts and service manuals for Moog products are still available, but EJE has not yet announced its policies regarding service for in-warranty Moog units. EJE Research Corporation, 2500 Walden Avenue, Buffalo NY, 14225 ☎ 716 / 681-7242.

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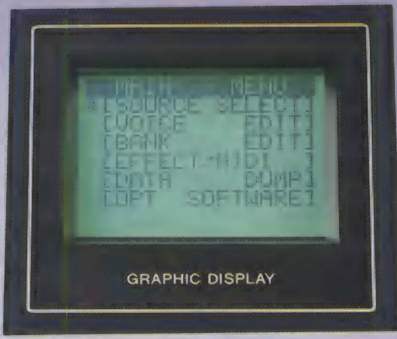

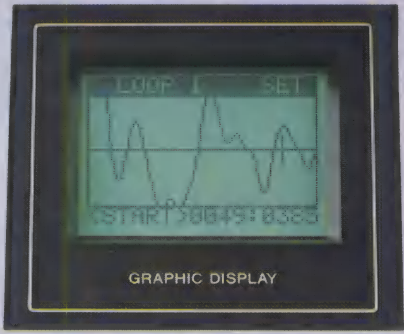

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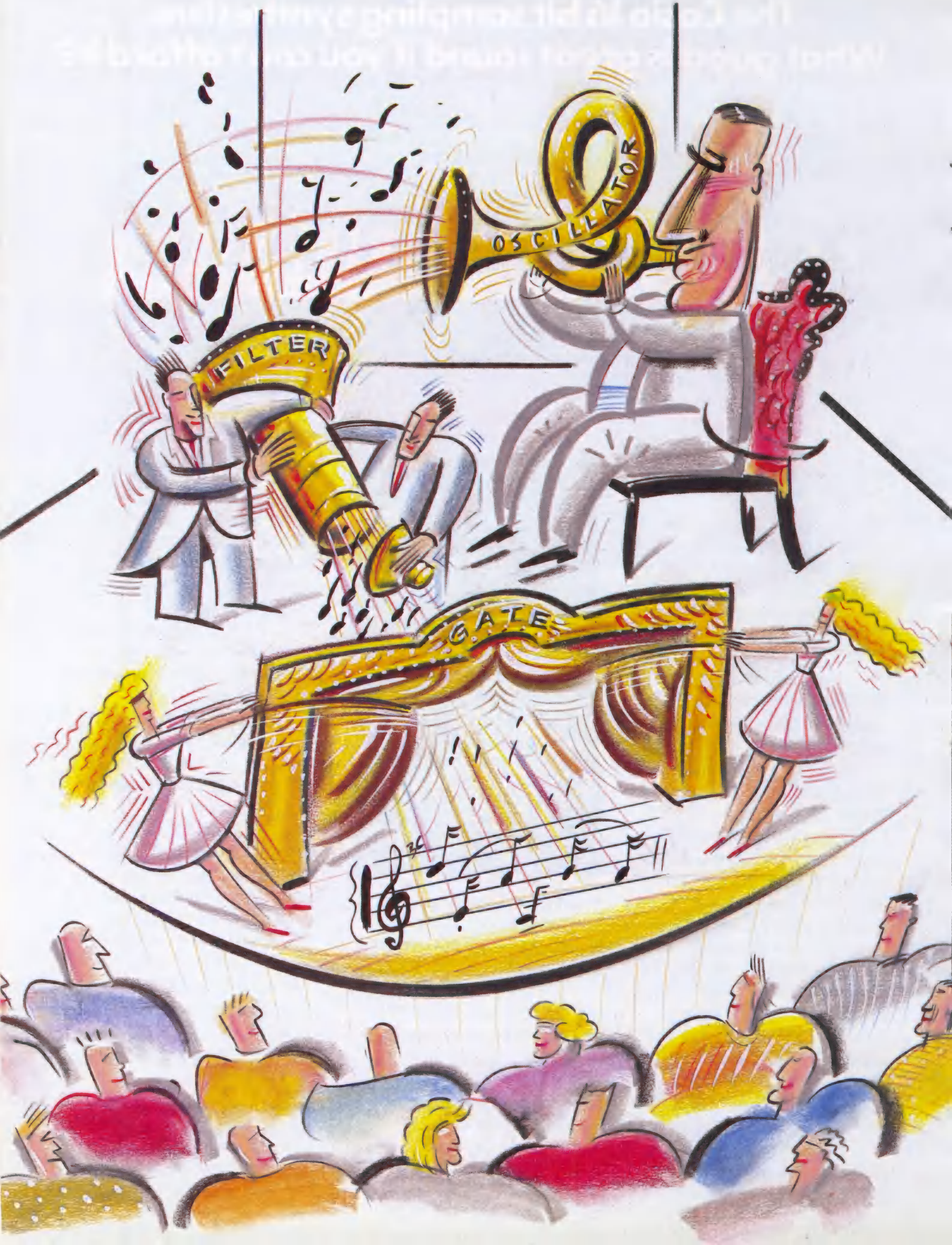
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They've been a mainstay of electronic music for over 20 years, they're less expensive than ever before, and they still make sounds the digital guys can't. Analog synthesizers have been receiving some digital assistance of late, but at heart, they're still analog synthesizers—and if you want to make them do magic, you need to speak their language. ∿ *This three-part article describes how synthesizers work, some of the "little" features that might be important for you to take into account when shopping for a synth, and finally, a guide to customizing canned software and factory patches for your own musical applications. Far from being "obsolete," with creative programming, analog synths have much to offer—and they still have the power to create sounds that can amaze and delight us.*

HOW ANALOG SYNTHESIZERS WORK

BY CRAIG ANDERTON

LIKE DIFFERENT AUTOMOBILES, different analog synthesizers are functionally pretty similar. This is because analog synth technology has been around for over 20 years now (the modern synthesizer was developed in the mid-'60s independently by Donald Buchla and Robert Moog), and design concepts that have stood the test of time are incorporated in most present-day synths.

What exactly is an analog synth? The term is becoming somewhat imprecise, since purely analog synths died out in the late '70s. These days, most synths are *hybrids* that combine analog and digital technology to varying degrees. However, a good working definition is that analog synths contain circuitry that operate on audio signals, rather than treating all audio signals as numbers and manipulating those numbers using digital techniques to change the sound. When you hear a Moog filter open up and give that wonderful, fat, resonant sound, you're hearing a circuit that's working directly on the audio signal—not a computer model that changes data to fit a software concept of what a filter is. Analog synths tend to sound somewhat less "sparkly" than digital synths, but make up for that with a richness of sound that even some of the best digital synths cannot duplicate. There's a reason why many musicians swear by their Moogs, Prophets, ARPs, and Oberheims, and why major companies—Ensoniq, Kawai, Korg, Oberheim, Roland, and others—still design synthesizers based on analog circuitry and concepts. But before we can get the most out of these wonderful instruments, we first need to examine how they work.

ILLUSTRATION BY MAX SEABAUGH

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HOW SYNTHS MAKE SOUNDS

The synthesizer creates musical sound through the use of *signal generating* and *signal modifying* (or *signal processing*) circuitry. The concept of having elements that make sounds, and elements that modify sounds, is common to much audio technology. (For example, in the studio, a multi-track tape recorder records and generates sound; these sounds are modified in the mixer via the use of equalization, reverb, faders to set level, and so on. A digital sampler has a digital recorder section that stores audio (analog) sounds, along with a bunch of signal processors to alter the stored sound.) Coupled with these two elements are *controllers* such as keyboards, modulation wheels, and so forth to allow you to interact with the signal-generating and processing modules.

With early synthesizers, no one knew what combination of generators and modifiers would sound good and what wouldn't. So, a synthesizer consisted of several signal generator and processing modules, whose inputs and outputs were interconnected by patch cords (which is why particular synth sounds are still called patches). Changing a patch involved manually repositioning patch cords, and remembering a patch meant notating the configuration on paper. Over the years, certain combinations of modules seemed to work better than others, and since patch cords were a pain to deal with, eventually these modules were wired together in a "normalized" configuration. Modern analog synths use "software patch cords" to interconnect modules and computer power to let you store settings in memory for later recall, but aside from these advances, the basic operational concept has remained virtually unchanged for over two decades.

In a synthesizer, the tone generator is usually an electronic circuit called an *oscillator*. This naturally raises the question "how do a bunch of wires make sound?"

Sound is variations in air pressure that are picked up by our ears and interpreted by our brain. If these variations happen in a regular (periodic) manner, they are said to have a *frequency*, and we perceive them as a tone. The frequency is specified in *Hertz* (abbr. Hz), which means *cycles-per-second*. Look at a vibrating guitar string under a fluorescent light sometime, and you'll see it vibrating in a regular fashion. The sound of rain, on the other hand, is a random phenomenon. Therefore, we don't hear it as a pitched sound, but as noise.

Speakers generate sound by moving a paper cone in response to current flowing through a magnetic voice coil attached to the cone. Thus, if you send a positive voltage into the loudspeaker, the cone moves forward. If you send a negative voltage into the loudspeaker, the cone moves backwards (assuming the speakers are wired correctly). If this voltage varies at a rapid periodic rate (at a frequency within the range of human hearing), then the speaker will move air that corresponds to a musical tone.

So, to generate a sound electronically, all we need to do is send a periodic voltage into a loudspeaker. By controlling the period of this voltage, we can create different frequencies—and yes, it really *is* that simple.

SIGNAL GENERATORS

Getting back to synthesizers, the oscillator is the element responsible for generating the periodic waveform. Periodic waveforms are very easy to generate electronically; there are five basic waveforms commonly used with traditional analog synthesizers. These waveforms consist of a *fundamental frequency* (which gives a sound its sense of pitch and is where most of the audio energy is concentrated), and additional audio energy in the form of *harmonics* (frequencies that are some multiple of the fundamental). The more harmonics, the more high-frequency energy, and the brighter the sound. Fewer harmonics means a duller sound. For precise information on the harmonic content of various waveforms, refer to any good book on acoustics (for some selections, obtain a free Mix Bookshelf catalog by calling ☎ 800 / 233-9604 in California; ☎ 800 / 641-3349 in the rest of the U.S.); for information on the harmonic content of different instruments, see Howard Massey's book *A Synthesist's*

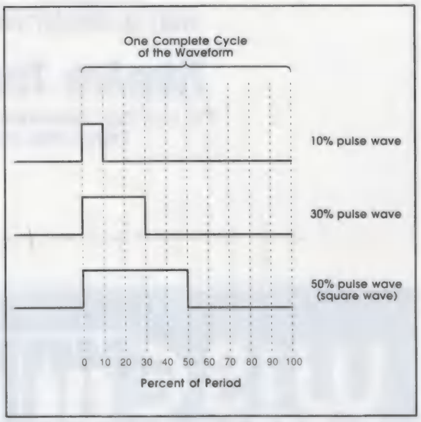
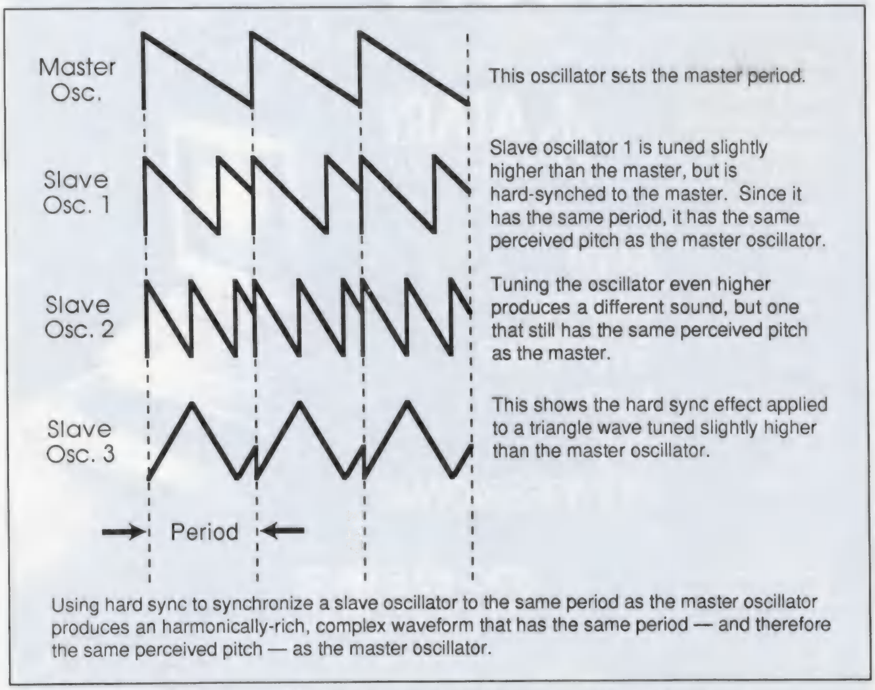


Fig. 1. *Pulse waves with different duty cycles.*



This oscillator sets the master period.

Slave oscillator 1 is tuned slightly higher than the master, but is hard-synched to the master. Since it has the same period, it has the same perceived pitch as the master oscillator.

Tuning the oscillator even higher produces a different sound, but one that still has the same perceived pitch as the master.

This shows the hard sync effect applied to a triangle wave tuned slightly higher than the master oscillator.

Using hard sync to synchronize a slave oscillator to the same period as the master oscillator produces an harmonically-rich, complex waveform that has the same period — and therefore the same perceived pitch — as the master oscillator.

Fig. 2. *How hard-synching one oscillator to another produces unusual waveforms.*

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Guide to Acoustic Instruments (published by AMSCO). For now, we will describe each waveform in terms of its sound quality.

Sine: This waveform consists, in theory, of purely the fundamental. In practice, though, it's very difficult to generate a perfect sine wave, so there usually will be some very weak harmonics that add a slight "buzz." Whistling produces a waveform that is pretty close to a sine, as do guitar strings towards the very end of their decay (especially if you're listening to the bass pickup with the tone control turned down). Most audio test generators emit sine waves.

Digitally stored or digitally generated waveforms should not be confused with samples.

Triangle: This is similar to the sine, but contains more harmonics and sounds very much like a clarinet.

Sawtooth: High in harmonic content, the sawtooth is the richest-sounding waveform. It is often used to synthesize orchestral washes and monster bass parts.

Pulse: Most pulse waves let you vary the *duty cycle*, or the percentage of time the pulse is high compared to the time the pulse is low (**Fig. 1**). Thinner pulses produce a reedy, nasal sound, while pulses with a 50% duty cycle—called square waves—produce a hollow kind of sound.

Noise: This is an unpitched sound source that generates a sound like falling rain or escaping steam. It is used a lot for percussive patches.

Some synthesizers take short pieces of periodic waveforms sampled from *existing* instruments (bass, piano, etc.), store them digitally, and use these waveforms in place of the standard oscillator waveforms described above. These digitally stored or generated waveforms are not samples in the normal sense; to show why, consider a piano sound. The sound of a piano is very complex and varies considerably over time, so just grabbing a few cycles of the sound will not necessarily sound anything like a piano. However, you will end up with a "natural-sounding" waveform that is unlike any of the five "standard" waveforms. Instruments like the Korg DW-8000, Ensoniq ESQ-1, Kawai K3, Roland D50, and so on offer multiple digital waveforms in place of, or in addition to, the standard synth waveforms; this translates into a greater variety of sound generators, which means more potential variety in your patches.

Most oscillators let you vary more than just the waveform. If the synth includes two oscillators, there usually will be a *detuning* control that alters the pitch of one oscillator with respect to the other oscillator. This creates flanging/chorusing type effects that help thicken up the sound. Sometimes you will also have the option of *hard-synching* one oscillator to the other. This is a little complex to understand. With hard sync, a *slave* oscillator is always locked to the period of the *master* oscillator. Thus, even if you alter the frequency of the slave, it has the same apparent *pitch* as the master since the period remains constant; what *does* change is the harmonic content of the slave. **Fig. 2** shows how hard sync can provide unusual waveforms in the slave oscillator. The sound that's produced is very nasty and harmonically complex.

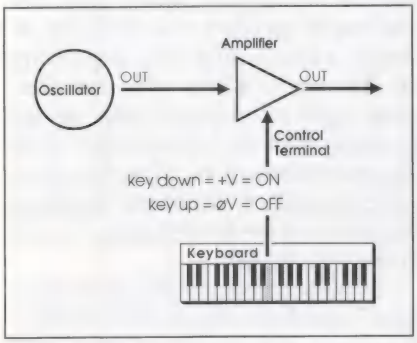

Fig. 3. *Gating the oscillator with a keyboard and amplifier.*

USING AN ENVELOPE TO ADD DYNAMICS

Usually a standard organ-type keyboard controls the oscillator pitch (although there are many alternate controllers other than the keyboard). However, just being able to control the pitch of an oscillator doesn't give us a very musical sound—we at least need some way to gate the sound on and off. The simplest option is to simply hook up an amplifier after the oscillator (**Fig. 3**). When the key goes down, the gain is high and input signals are passed to the output; when the key is up, the gain is zero, so nothing makes it past the amplifier.

This is a start, but we still need more control. The only instrument that cuts on and off is the organ; some instruments decay over time (percussion, drums, plucked strings, etc.), while some require a bit of *attack time* to reach full volume (like woodwinds, brass, and some bowing instruments). What we need is some way to *alter gain over time.*

One option would be to simply turn a knob that varies the gain of the output amplifier. Unfortunately, this method is neither fast nor repeatable, and requires that you use one of your hands on the knob instead of the keyboard. A much better option is to use a *Voltage-Controlled Amplifier* (VCA) whose gain re-

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sponds to a voltage applied to a special control terminal (more voltage gives higher gain, less voltage gives lower gain). Then all we need is a device that, in response to pressing a keyboard key, generates a series of voltage changes that alter the VCA gain exactly as we want. If the voltage ramps up slowly from full off to full on, the gain will increase slowly over time and give an attack effect. If the voltage goes from full on to full off, we'll hear a decay.

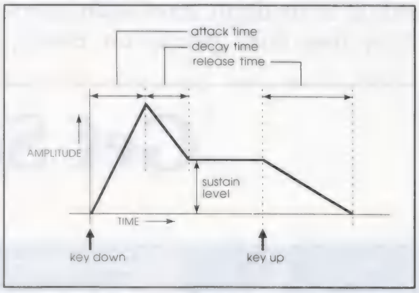

Fig. 4. *The four stages of an ADSR envelope generator.*

The circuit that generates this voltage change is the *envelope generator*. Normally, it produces no voltage; but as soon as you strike a key, this circuit leaps into action and generates a varying voltage to control the VCA. The most common type of envelope generator is the *ADSR*, so named because there are four voltage stages called Attack, Decay, Sustain, and Release.

Fig. 4 shows the effect and timing of the various envelope parameters; refer to these as you read the following descriptions of the four basic parameters.

Pressing a key initiates the *attack* phase, where the envelope output goes from full off to full on. This can take anywhere from a few milliseconds to a second or more, depending on the attack time control setting.

After reaching maximum level, the *decay* phase kicks in. This determines how long it will take for the envelope to decay from its highest level down to the *sustain* level. The sustain setting is not a time, but rather, a voltage level (corresponding to an amplitude/volume level) that is maintained for as long as the key is held down. Setting the sustain to zero gives a signal that attacks and then decays down to nothing; this is called an AD (for the two stages: Attack and Decay) type of response.

Releasing the key initiates, not surprisingly, the *release* phase. This is the time it takes for the envelope to go from the sustain voltage back to zero.

The four-stage ADSR is not the only type of envelope generator; newer technology has brought us the multi-stage, Rate/ Level type of envelope. This type of envelope offers more than just four stages, and while the sustain parameter is the same as that in the ADSR, attacks and decays are created by specifying a *level* you want the envelope to attain, and the *rate* of time it takes to reach that level. **Fig. 5** shows how using a six-stage version of this type of envelope can give a "double attack" by setting a moderately fast rate to the maximum level of the first stage; a slower rate to a lower level in the second; a fast rate to almost the maximum in the third; a slower rate to the sustain level; and finally, a slow rate from the sustain level back to zero. The end may be specified as an End level, or simply, a level setting of 00, depending on the synth. While more complex, these types of envelopes offer greater flexibility than the "old standby" ADSR (for more information on Rate/Level envelopes, see Clark Salisbury's "Envelope Intimacy and the Art of Shaping Sound" in the June '87 **EM**).

By the way, many analog synth functions—envelopes, VCAs, and so forth—are now implemented digitally (often through software programmed into a computer) instead of with dedicated integrated circuits. However, from a user standpoint, an envelope is an envelope, no matter how it is generated. These days, an "analog synth" may well consist of mostly digital circuits, but since it produces the same sounds and uses the same principles of operation as traditional analog synthesizers, it requires similar programming techniques and can be treated similarly from a conceptual standpoint.

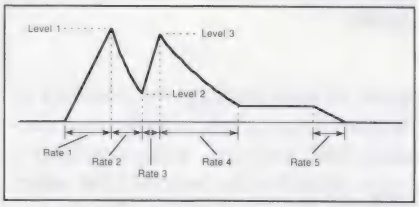

Fig. 5. *Using a Rate/Level envelope to give a double attack.*

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There's more to sound than dynamics: harmonic structure, for example. A *low-pass filter* can vary the harmonic content of a signal by blocking all audio energy above a specified *cutoff frequency*. Setting a high cutoff frequency means that most of the high frequencies will remain, but setting a low cutoff frequency will dull the sound considerably by removing harmonics. Although static filter settings are useful, it's often more desirable to vary the filter setting over time. We use the same approach as with the VCA—make the filter cutoff respond to a voltage, and use an envelope to vary (control) the cutoff frequency.

The typical filter has controls for the *initial cutoff frequency* and *envelope depth*. Envelope depth determines the *range* over which the filter will be swept (the greater the depth, the greater the sweep range), while the initial cutoff control determines at what frequency the sweep will *start*. So these two controls interact; if you want to sweep a specific frequency range, first set the lowest frequency with the initial cutoff control, then increase the depth until the envelope sweeps the desired maximum range.

Some filters allow you to invert the polarity of the envelope so that the filter sweeps downward instead of upward (**Fig. 6**). In this case, the initial cutoff frequency determines the *upper* limit of the sweep, while the depth control determines how far *down* the cutoff frequency will be swept. Many people find this mode confusing, but just remember—if you use an inverted envelope, then use the initial cutoff control to set the upper limit of the sweep, not the lower.

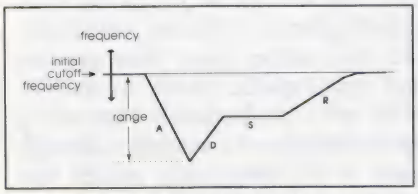

Fig. 6. *An inverted ADSR (or other envelope) sweeps downward from a high initial filter cutoff frequency.*

Note, by the way, that filter and VCA envelope settings interact. For example, if the VCA is set for an extremely short decay, then you won't hear the effects of setting a long filter decay because the volume of the sound will reach zero before the filter decay is complete.

Many filters also have a *tracking* control. This oft-misunderstood control is very useful; it varies the filter cutoff frequency with respect to which note(s) are being played on the keyboard. Usually the setting is referenced to a setting of 1.00, where the filter cutoff precisely tracks the keyboard pitch. Thus, if you have a certain harmonic structure when you play one key, playing a different key will shift the filter frequency in order to maintain the same harmonic structure. This generally gives the most realistic synthesizer and instrument sounds. With 0.00 tracking, the filter will not be affected at all by keyboard pitch. This is useful for bass patches where you want the lower notes to have more highs, and the high notes to become progressively more muted. With tracking settings higher than 1.00, the filter cutoff will increase at a *faster* rate than pitch as you play up the keyboard. For example, with a tracking setting of 2.00, increasing the pitch by one octave will raise the filter's cutoff frequency by two octaves. This technique comes in handy when you want upper keyboard register leads that really "cut" while the lower registers sound more muted and sedate.

Synth keyboards used to be a series of simple on-off switches. . .fortunately, many keyboards now boast velocity- and pressure-sensitivity.

The low-pass filter is only one member of the filter family, but it is the mainstay of virtually all synthesizers. One exception is the Oberheim Xpander, whose multi-mode filter offers 15 different filter types, including several variations on the traditional low-pass.

THE KEYBOARD

Synth keyboards used to be a series of simple on-off switches. The action was therefore like playing an organ, which limited the synth's dynamic capabilities. Fortunately, many keyboards now boast *velocity-* and *pressure*-sensitivity. Velocity measures the time it takes for a key to go from up to down, and (usually) translates shorter times into louder dynamics. Pressure (also called *Aftertouch*) measures pressure exerted on a key after it has already been pressed down. This is great when you want to introduce vibrato, pitch bend, or other types of expressive effects by just pressing the keys. A few keyboards offer *polyphonic pressure*, where pressure is measured for each key; but most keyboards simply take an average pressure reading of all keys that are down and use that to provide the pressure data.

LOW-FREQUENCY OSCILLATORS

We've almost completed our tour of the synthesizer, but we need to consider the *Low-Frequency Oscillator* (LFO). This module creates a cyclic (periodic) modulation of synthesizer parameters such as pitch, volume, or filter cutoff. Applying a periodic modulating signal to the oscillator provides vibrato; this is deemed such an important application that many synthesizers include a *modulation wheel* designed for real time manipulation that adds vibrato, as desired, under the player's control. Applying modulation to the VCA produces tremolo; modulating the filter cutoff with an LFO signal produces a wah-wah effect or, if used subtly in the higher registers, a shimmering type of sound. Using an LFO can create a more animated sound, particularly if it is applied to varying the pulse width of a pulse wave. This produces a sound that is very similar to flanging, even with single-oscillator synthesizers.

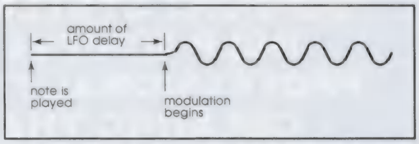

Fig. 7 *LFO delay alters the onset of modulation.*

A popular LFO feature is *LFO delay*, where modulation is not introduced immediately upon playing a key but rather, only after a programmable amount of time has elapsed (**Fig. 7**). This provides a more natural modulation effect, as most musicians do not introduce vibrato immediately upon playing a note.

FINDING YOUR VOICE

Adding all these elements together—an oscillator or oscillator pair to create sounds, a filter to vary harmonic structure, a VCA to vary dynamics, an envelope generator or two, and an LFO or other modulation circuit—produces a single note we refer to as a *voice*. Early synths, like the minimoog, only could play one note at a time and were called *monophonic* instruments. Newer synthesizers can play several notes at once and therefore are considered *polyphonic*; these synths duplicate the modules listed above for *each* voice (well, some might only have one LFO for all voices, but we're quibbling here). As you can probably figure, more voices mean more circuitry and more expense but also let you play more notes simultaneously. Most analog synths are eight-voice machines, although some of the lower-priced models may only have six voices or so.

> **An analog synthesizer can generate a stunning array of warm, expressive sounds.**

Of course, there are many other synthesizer bells and whistles unique to individual synthesizers—too many to go into here, in fact. That's why owner's manuals are well worth reading; it pays to discover what particular little goodies are built into your synth, since taking advantage of these will enable you to create a more individualized sound. Still, even with just the basic elements mentioned above, an analog synthesizer can generate a stunning array of warm, expressive sounds. Experiment, and your efforts will be well-rewarded.

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Shopping for a Synth: Sometimes the Little Things Count

WHEN SHOPPING FOR A SYNTH, most people know to look for major features like the amount of patch storage, whether split and layered keyboard configurations are possible, and so on. But paying attention to features that make it easier to program sounds is very important if you want to attain your maximum level of creativity. I've found the following features to be very useful when programming synths; of course, no one synth has all the features listed below, so pick the ones with the greatest relevance to your needs and desires.

1. Dual envelope generators.

Lower-priced synths use one envelope generator to feed both the VCF and VCA (Voltage-Controlled Filter and Amplifier). While this is adequate in most cases, having a separate envelope generator for the VCF and VCA gives more flexibility. It's even better if there's a third envelope generator for the VCO (Voltage-Controlled Oscillator), or some means of switching one of the other envelopes to the VCO when desired.

2. Autobend for better patches.

Being able to bend up or down to pitch via a programmable amount helps greatly when synthesizing wind, plucked string, fretless, and percussive instruments. Wind instruments tend to start off slightly flat and bend up to pitch; plucked strings and drums start off slightly sharp and bend down to pitch. With fretless instruments, few instrumentalists can hit the exact right pitch—like vocalists, they'll start a little flat and slide up to the right pitch. These are subtle effects, but programming them in can greatly aid in the realism of a patch. If an autobend function isn't available, check whether an envelope generator can be pressed into service to perform the same function.

3. Multi-timbral operation.

A multi-timbral instrument lets you assign different voices in the synth to different sound programs and different MIDI channels; thus, you can have more than one sound available from a single synthesizer when driven by a MIDI sequencer. For example, with an eight-voice, multi-timbral instrument, you might assign six voices to play a piano part on channel 1, and two single-note percussive effects to play on channels 2 and 3. This kind of feature helps stretch your synth's value.

4. MIDI volume over controller 7.

MIDI continuous controller 7 can carry master level data that determines the overall volume output of a synth. Before implementation of this MIDI parameter became commonplace, programming level changes meant programming several patches at varying volume levels, and initiating a patch change when appropriate. This technique uses up memory slots, though, and changing patches might produce a short glitch. Using controller 7 data (typically from a sequencer) to control volume lets you get more mileage out of a single patch.

5. On-board signal processing.

Some synths have built-in chorus, delay, and so on. This gives two big advantages: you don't need to tie up bucks in an external processor, and frequently, the signal processing parameters can be stored as part of a patch. It's like getting a MIDI signal processor for free.

6. Dual oscillators.

Most people like dual oscillators because they can be detuned slightly to create a "fatter" sound, but you can accomplish the same effect with a single-oscillator synth and an external chorus unit. The reason I like dual oscillators is because you can tune them to different intervals (octaves and very high harmonics are my favorites); also, synths with two oscillators often allow hard sync, a nasty-sounding synth effect that's real good for rock leads and bass parts.

7. Velocity and/or aftertouch sensitivity.

Velocity responds to the dynamics of your playing, aftertouch to pressure exerted on a key after it's down. Both allow you to build more expressiveness into your patches.

8. Lotsa user-programmable patches.

Preset machines where the sounds are etched in ROM and cannot be altered (except temporarily) are great for getting up and running with a minimum of effort, but they're a drag if you like to come up with your own custom sets of patches. Fortunately, the patch storage space problem can be alleviated with voice editing software but this is not extremely practical for quick patch changes in a live performance situation.

9. Availability of voice editing software.

Parameter-control synths, where you only can adjust one parameter at a time, make for tedious programming. A good voice editor will, in conjunction with a personal computer, display all parameters simultaneously so that you can get an overview of your patch. Some editors let you print out hard copies of patch data, set up libraries of particular patches, randomize parameters, and other goodies.

10. Edit/compare option.

It's very handy to compare an edited version of a patch with the unedited version to see which one you like better. Most newer synths have this feature; with older synths, one trick is to dedicate a specific patch location as an "edit buffer." Copy the patch to be edited over to the buffer, and do all your editing in that location. As needed, you can compare the edited version to the unedited version. When you like the edited one more than the original, overwrite the original patch.

11. Multiple oscillator waveforms.
The more waveforms, the better. Synths that only produce square and sawtooth waves will always tend to sound a bit "buzzy"; having triangle and pulse waves makes a big difference. Even better are the synths that offer multiple digitally generated waveforms (Ensoniq ESQ-1, Kawai K3, Roland D50, Korg DW-8000, etc.) as these allow for more options.

12. At least one "soft" knob.
Most synths have pitch bend and modulation wheels, but sometimes you want to be able to change some other parameter, such as envelope attack, filter cutoff, etc. If your synth uses a knob for parameter value selection, you can call up the parameter you want to vary in real time, and use the knob to make the desired adjustments. This technique is not convenient with synths where parameter values are entered with a numeric keypad (although these kinds of synths generally cost less).

13. Step or link feature (up/down footswitch).
Although this feature is less relevant these days since most synths can receive MIDI program change commands, sometimes it's easier to just set up a preset series of patch changes for a song and step through them with a single press of the footswitch during live performance.

14. Number of voices.
I'm often asked why some synths have, say, 16 voices when you only have ten fingers anyway. The answer is that if a patch has a significant amount of envelope release time, a note can continue to sound even after you've taken your finger off the key. If all the available voices are sounding, then trying to play a new note will "steal" one of the voices, thus cutting short the envelope's release phase and producing an unpleasant truncation effect. Although you'll seldom run into this problem with short, percussive patches, string washes and other long-release sounds often need all the voices they can get. One alternative to putting a lot of voices on-board is the MIDI "overflow" mode offered by some synths; if all the voices in the synth are tied up, extra notes are re-directed out the MIDI port to a second synth module.

15. Availability of patch support.
It's useful to have lots of third-party patch support available. Even if you create all your own original programs, you can learn a lot from other people's programming techniques, and these patches often serve as an excellent point of departure for your own experiments.

16. Lack of fans, buzzes, and transformer hum.
Listen to the sound your synth makes when you're *not* playing the keys. I realize cooling fans are a necessary evil in much high-tech gear, but that doesn't mean I have to like them.

As mentioned at the beginning, no one synth has every desirable synth feature imaginable. But if some of the ones above sound important to you, take them into account when looking for a good analog synth.

Customizing Canned Software and Factory Patches

NO ONE SAID PROGRAMMING a synthesizer would be easy, especially the parameter-control types where each parameter must be programmed individually. For those who would rather not spend time programming, there are a number of "canned" software packages available, as well as the ubiquitous factory patches.

However, great patches are made, not born: even the world's best programmer isn't going to take *your* needs into account when creating patches. A program that sounds great going through studio monitors may not sound all that good going though a budget synth amplifier, and a string part that sounds fantastic behind music with a slow tempo may turn to mush when the tempo gets more upbeat. More often than not, musicians evaluate factory patches or canned patches by listening to each preset for about 10 seconds, tickling the keys for a bit, then deciding that the sounds are "no good."

Just as tailors have to alter clothes to fit specific bodies, synthesists have to edit programs to suit specific musical applications. If a program works for you "out of the box," you're lucky. Most of the time, you'll need to do some editing. In the following examples, we'll suggest how to set the synth's controls (or occasionally, the controls of an outboard signal processor) to obtain specific musical effects. That way, if you call up a patch and it's not "bright" enough, look under "bright" for some suggested remedies. Relating parameters to musical terms also is useful if you work with non-technical producers and musicians who cannot relate sounds to control settings. Good luck with your tweaking!

More "animated" *(also applies if a sound is "too static"):*
1. Select a pulse waveform and add slow pulse width modulation. This creates a flanging type of effect. **2.** Turn on internal chorus (if present), or use external digital delay set for flanging/chorusing. **3.** Detune oscillators somewhat if a dual-oscillator

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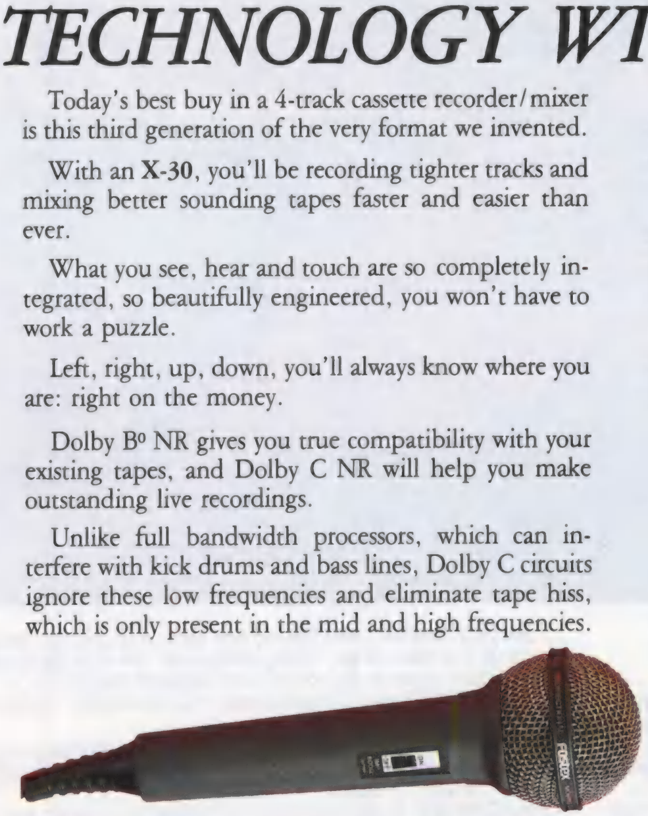

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© 1987 Fostex Corporation of America ● 15431 Balckburn Avenue ● Norwalk, CA 90650 ● (213)921-1112 machine, or add subtle, slow vibrato to one of the oscillators (in either case, mix the second oscillator at a somewhat lower volume level than the first oscillator to minimize phase cancellation problems). **4.** Add subtle, slow LFO modulation to the filter cutoff frequency.

Brighter *(also "less dull"):*
1. Change oscillator waveform to one with lots of harmonics (i.e. sawtooth, narrow pulse). **2.** Increase filter (VCF) cutoff frequency, filter envelope generator sustain level, or filter envelope amount. **3.** If the filter is not being swept by an envelope, tune the filter up fairly high and add a bit of resonance. **4.** Boost high frequencies with outboard equalization.

Fatter:
1. Add in sub-octave waveform (if available). **2.** Mix in second oscillator tuned one octave below main oscillator. **3.** Boost lower midrange (500 Hz on down) with external equalizer. **4.** Add chorusing with about 20 ms of initial delay and a fairly slow sweep rate. **5.** If the filter is not being swept, tune the filter to around 500 Hz or lower and add a little bit of resonance to boost those frequencies. You may have to turn up the volume a bit to compensate for the lower signal levels associated with increased resonance.

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One of the problems with using canned software involves not timbre, but *rhythm.* Whether a sound is "in the groove" or not depends greatly on the envelope generator settings.

• • • • • • • • • • • • • • • •

Hollower *(also "less sharp" or "more reedy"):*
1. Change waveform to triangle or square wave (or pulse with 50% duty cycle). **2.** Add external flanger set for short delay, no modulation, and about 50% feedback.

More muted *("duller"):*
1. Choose waveform with fewer harmonics (triangle, sine). **2.** Reduce filter cutoff frequency. **3.** Reduce resonance. **4.** Decrease filter cutoff frequency, filter envelope generator sustain level, or filter envelope amount.

More percussive:
1. Set VCA or VCF envelope generator attack time to zero and reduce the initial decay time. It also may be necessary to lower the sustain for any change in decay to be apparent. **2.** If you want a fairly sustained sound combined with a sharp percussive attack, this precludes lowering the VCA sustain control. In this case, keep the VCA envelope generator parameters as is (but make sure the attack is at minimum) and set the VCF envelope

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generator parameters as described in step (1).

Sharper sound:

1. Increase filter resonance (note: this also may thin out the sound). **2.** Select hard or soft sync and vary the frequency of the slave oscillator being synchronized (controlling this oscillator's frequency with the pitch bend wheel or lever can produce some great effects).

Thicker:

1. Select waveform with high harmonic content. **2.** Turn on internal chorus. **3.** Add short echo with external digital delay. **4.** Add slight amount of distortion with external processing to increase amount of harmonics.

More sheen:

1. If the filter is not being swept, turn up resonance about ⅓ to ½ of the way, and tune the filter up to the highest frequency where the increased resonance is still audible. **2.** Add a harmonic booster such as the Aphex Aural Exciter, EXR Projector, Harmonic Sweetener (Sept. **EM**), etc.

Thinner:

1. Change waveform to narrow pulse width or waveform with low harmonics (triangle, sine). **2.** Turn off one of the oscillators in a 2-oscillator synth. **3.** If present, turn off internal chorus or change filter mode from low-pass to highpass.

Warmer:

1. Reduce filter cutoff somewhat. **2.** Reduce resonance. **3.** Add chorusing or doubling. **4.** Use external equalizer to boost bass and lower midrange. **5.** Lower vibrato speed slightly (if used). **6.** Mix in a little bit of signal from a second oscillator tuned an octave below the primary oscillator. **7.** Use sawtooth waveform for richer sound.

Wetter:

1. Add chorusing. **2.** Reduce filter cutoff somewhat, or use waveform with few harmonics (triangle, sine). **3.** Add reverb or delay with external signal processing.

The above tips all relate to sound quality. However, one of the problems with using canned software involves not timbre, but *rhythm*. Whether a sound is "in the groove" or not depends greatly on the envelope generator settings. An envelope set for a long release time, or a long attack time, usually will not sound right with up-tempo pieces. Conversely, with more legato playing you can use longer attack and release times. If a sound is good on its own but doesn't fit with a particular piece of music, try altering the envelope times. In particular, release times are crucial. Many canned patches come with short release times to be more universally applicable, but increasing release for slower-paced tunes can help make patches—particularly pads and washes—sound fuller and create a feeling of ambience. **EM**

***Craig Anderton** is still trying to figure out exactly how he got from being a touring rock and roll musician to a magazine editor. He thinks it may have something to do with sunspot activity, or perhaps diet.*

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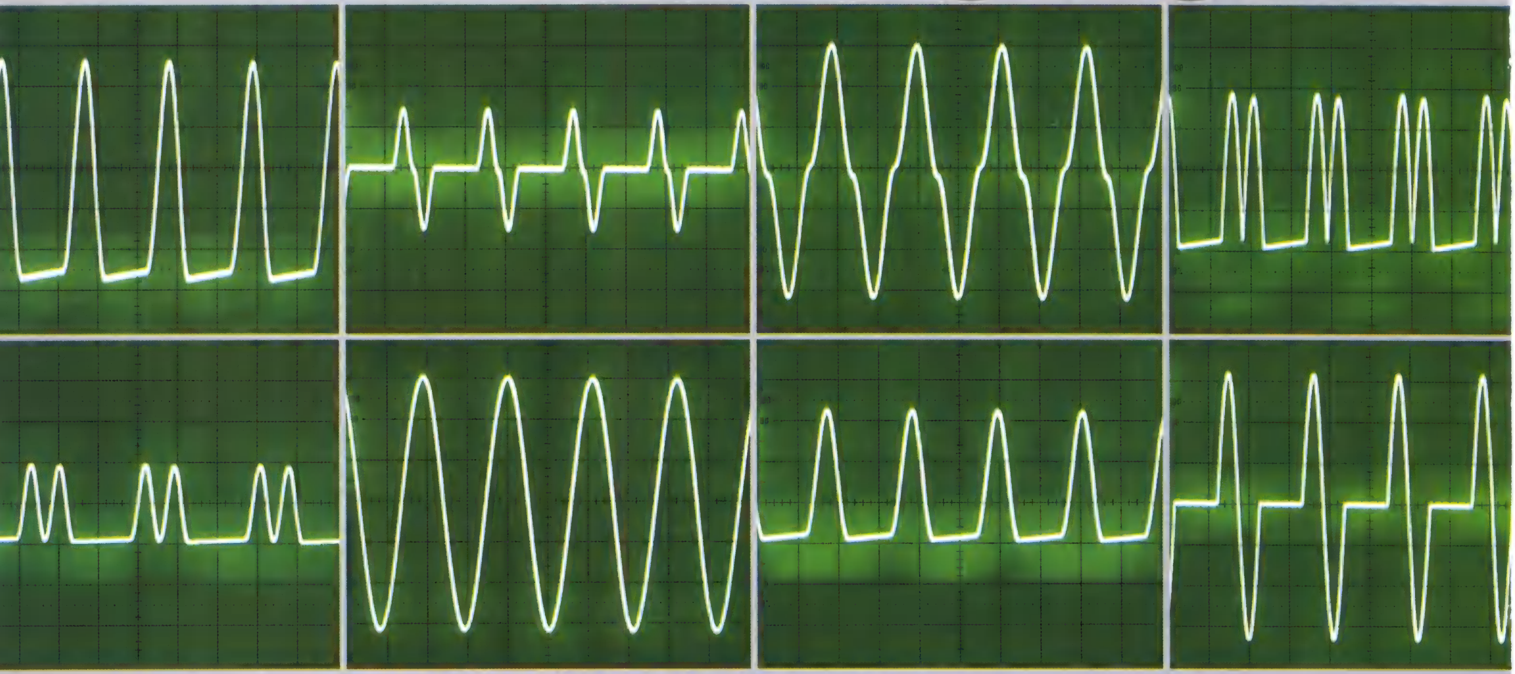

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This not only increases the almost limitless sound possibilities of FM, it also gives the four-operator TX81Z a "six-op" sound. Yet the TX81Z is still compatible with other Yamaha four-operator synths and tone generators.

The TX81Z's Play Single mode lets you play voices with 8-note polyphony. There are five banks of 32 voices to choose from, including 128 preset voices and 32 user voices, programmable from the front panel.

Twenty-four additional performance memories let you play up to eight voices at one time. Instrument 1, for instance, could be a piano voice with 5-note polyphony while instruments 2, 3 and 4 could be monophonic voices. Note limits, MIDI reception channel, voice numbers, detune and volume settings for each instrument can be instantly changed in this mode.

Eleven preset and two user-programmable micro-tunings let you play a harpsichord voice, for instance, in authentic mean-tone temperament, or gongs and bells in Balinese gamelan scales.

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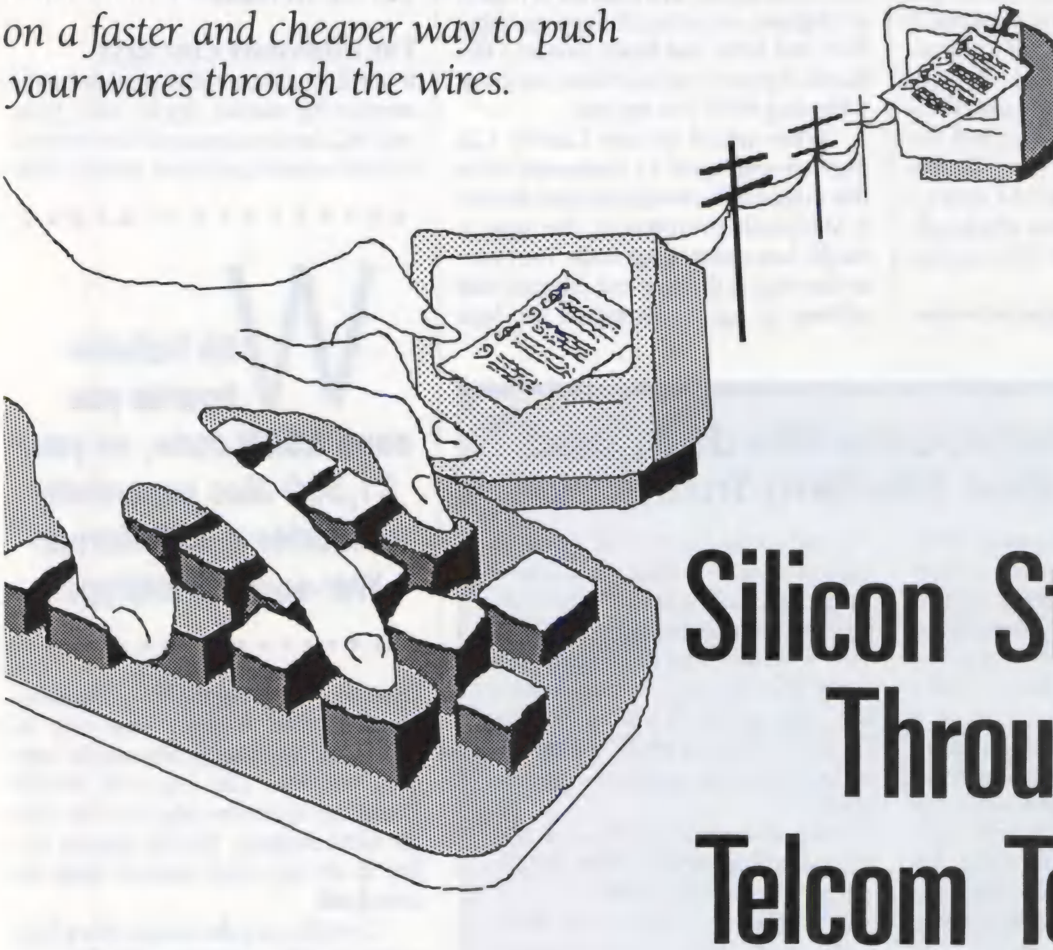
For any of you who send either your words or your music via the magic of Macintosh and modem, here's the word on a faster and cheaper way to push your wares through the wires.



Silicon Strollin' Through Telcom Terrain

By Craig O'Donnell

Visualize this: my friend Peter has a Mac and modem. I have three *vital* Sound Designer files to send him. His Tuesday message on my answering machine says his Agent (software for answering modem transmissions) will run 8 'til midnight PDT (Pacific Daylight Time) on Wednesday while he's out for sushi. Fine. I get home Wednesday night at 11:15 PM CDT (Central Daylight Time)...oops, running late. Glad he's not waiting there for me to call him. I open *Courier* Peter-H (his number is stored there) and press Command-R.

Log-on is smooth; his Agent greets me, adjusting its speed to 2400, 1200, or 300 Baud automatically. Yesterday I compressed, combined and encrypted the files with PackIt III so I have one file, rather than three, to send. I send it and then download what he's left for me. All we had to do was set a time, and which Agent to use. I pay for a phone call, nothing more, with PackIt saving me 25% or so in transfer time. No Federal Express. No on-line services. It cost us $30 to get the software to do this.

Product Summary

Names: Agent and Courier 1.21
Type: Macintosh Bulletin Board Shareware
Price: $30
Manufacturer: Buck, Wheat and Associates
Address: 1601 Weatherstone Drive, Blue Springs, MO 64015.

The "No BS" BBS

Science fiction? Nope. Mac-to-Mac transfers of applications and files—not just text—are simple with the Courier/Agent combination. It cuts BBS (bulletin board service) BS by limiting your options. Courier (the *front end*) *only* calls an Agent, and Agent (the *mini-host*) *only* answers a Courier. Agent-to-Agent is impossible; so is Courier-to-Courier. Even better, all this is pretty well automated—we're talking about what might well be the world's *easiest* personal computer telcom application.

In general, modem owners have a

ILLUSTRATION BY ROBIN SENOUR

great advantage: an IBM chats with a Mac, they both talk to a Tandy 102, and we all log onto the host computer across the street or across the nation. But we're using least-common-denominator *text files* that conform to the standard ASCII (American Standard Code for Information Interchange) protocol. Bulletin boards and on-line services use ASCII code between you, the caller, and the host. You transmit ASCII (text) files as strings of numbers (e.g., @ = 64, space = 32, etc.), so your $1,500 Mac essentially emulates a $29 Korean War-surplus teletype.

One-on-one modeming is even worse. On commercial services it's fairly easy to leave files for others, but connecting with another individual is a tedious, time-consuming nightmare fraught with potential error: call, talk, switch software to *Answer* or *Originate*, set protocols, type messages back and forth, and finally transfer a file. Eucch. If you've ever tried this, you know a big drag when you see one.

When two of us have Courier 1.21 freeware and Agent 1.1 shareware, we're free to blast off in an efficient user-friendly Macintosh environment. The *Agent* is the *file-host* and message node. The *Courier* freeware is the *front end* program that phones an Agent running on any Mac (except for the original Mac 128 model).

Musicians into Mac MIDI can swap and share work files, instrumental parts, sound files, and samples at minimum cost with zero hassle.

THE CORPORATE CONTRAST

In a bid to capture what promises to be another *big* market, Apple, Dow Jones and MCI have announced *their* electronic mail (e-mail) document service, *Desktop Express*, with three levels of file transfer (scheduled to begin some time in 1987). Mac application files may be sent from one Mac user (say with Master Tracks Pro) to another Mac user who has the same program. The file appears online in an MCI Mail mailbox ready for download.

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With bulletin boards you send ASCII code, so your $1,500 Mac essentially emulates a $29 Korean War-surplus teletype.

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Using the popular image-saving Mac accessory, *Glue*, someone with a Mac can make screen-readable and printable documents for e-mail transfer when the recipient *doesn't* have the creating application but does have Desktop Express and a Mac. Those with Desktop Express can also send laser hard copy to anyone via MCI Mail's LaserWriter Plus printers and Uncle Sam's own weatherproof courier, the US mail.

Desktop Express's $149 price includes the Mac-to-Mac icon-driven telcom application and first year sign-up fee waivers on MCI and DJNS (the Dow Jones News Service). The latter services then take a few pesos from your pocket every time you send a file. Though Courier-Agent behaves much like a personal mini-Desktop Express environment, Courier is freeware and Agent is $30 shareware. I'm amazed: your own file-sharing network for $30 and the price of a phone call.

Some Hard-Come Wisdom and Assorted Modem Truths

The newest modems are much alike. Prices have been plummeting, so buy a 1200 Baud model, or better yet, one that goes at 2400 Baud. Unfortunately, used modems aren't much of a deal unless they're a name brand, 1200+ Baud, and under $100.

Mail order is a good source, since modems are not easily damaged. External types work with just about any personal computer, given the right cable. Cards (internal modems) for IBM, clones, and the Apple II are available. Expect cards for the Mac SE soon. There is also a new MacBottom SCSI hard drive with a modem in it, too. Great idea.

Look for *100% Hayes AT compatibility* to avoid software trouble. Hayes pioneered the microprocessor-equipped *smart modem*. The software shoots commands to it, and it processes them. This takes a burden off you and your Mac. If a unit understands Hayes commands, the software/modem combination will perform reliably. Makers strive to be Hayes-compatible, because modems sell poorly if they aren't.

BRANDS AND PRICES

All run at 1200/300 Baud, except as noted. Prices are representative and intended to serve only as guidelines; like everything else in the computer business, prices and specs are subject to change without notice. For addresses and recent prices, check out the ads in recent Macintosh-oriented magazines such as *MacUser* (c/o Ziff-Davis, One Park Avenue, 4th floor, New York, New York 10016) and *Macworld*, (c/o PCW Communications, Inc., 501 Second St., San Francisco, CA 94107) both of which can usually be found at Apple dealers or on newsstands.

✓ Hayes—compact, bulletproof, and pricey: Smartmodem 1200, $350+; Smartmodem 2400, $550+.

✓ U.S. Robotics—Courier 1200, $172-$199; Courier 2400, $345-$419; Direct 1200, $119. Courier HST (9600 Baud), $800-$900.

✓ Apple—Personal Modem, $399 list; check your dealer and see if you can get a better deal. In my opinion it's overpriced, but it is handsome and small.

✓ Avatex 1200hc—Good features, voted "best buy." One company, Megatronics, offers them for $129.

✓ Mercury Modem from Computer Friends, $149 plus $4 shipping.

✓ DAK Hayes-compatible ADC, $135.90 including shipping (1-800-423-2866 for info).

✓ Chicago's PC Network R.T.H.E.S brand, $119 (2400 Baud $220). Anchor *Lightning 2400*, $309.

✓ USA-Flex Incomm Turbo 2400, $249; Desktalk 2400, $199.

—C.O'D.

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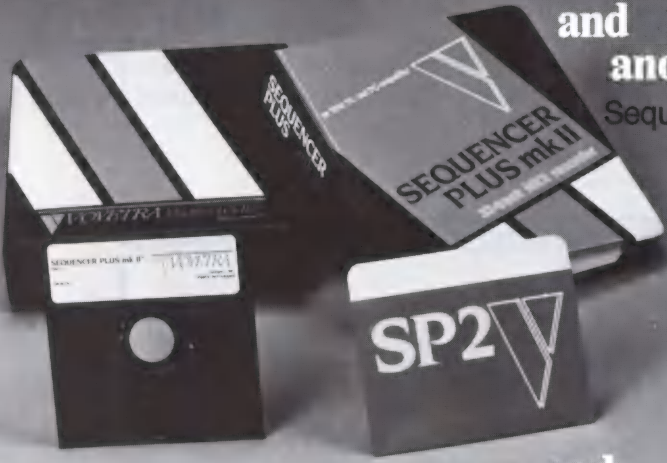

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CHOICE

After three years of refinements, **Sequencer Plus** has become the most **powerful**, most **professional** and most **versatile** MIDI sequencing software available in the world today.

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Introducing, the **Sequencer Plus Series: Three new versions**, each with differing levels of sophistication offering a system that will *grow with you* instead of being outgrown.

Sequencer Plus Mark III (Sp3) is a *"No Compromise" powerhouse!* 64 music tracks with independent offsets, tempo track, song position pointer, chase mode, extensive and selectable MIDI Filtering, 17 transform functions, block editing of multiple tracks, 11 memory buffers and a list of additional features that reads like a computer musician's wish list!

Sp3 also transmits patch files created with **Patch Master**, our unique *MIDI network organizer/universal librarian* program that supports virtually every major synthesizer.

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MUG'S UNIQUE APPROACH

Developers Buck, Wheat & Associates run the *MacUnderground* (MUG), a national on-line user group/magazine/BBS with 19 *Safehouses* located around the country. Mac reviews, late news, rumors, desk accessories and all things Mac-like are available for downloading by subscribers. Unlike many BBSs however, Safehouses do not directly support user-to-user bulletin board messages unless the sysop (system operator) specifically provides a private-mail section. Rather, MUG is mainly a *file-exchange medium* and Safehouses run a high-octane Agent Host, of which the shareware Courier-Agent is a spinoff.

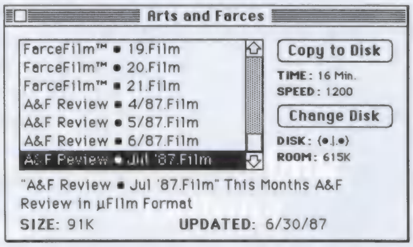
The Courier shareware is a highly simplified user interface that differentiates MUG from GEnie, PAN or your local BBS. Courier 1.21 with its auto log-on can call either MUG or your personal Agent. With the proper number of copies of Courier (freeware, remember) you can create a workgroup network with one or more copies of Agent acting as the BBS minihost(s) for all callers. If everyone in the workgroup has registered to get Agent, anyone can send files to anyone else simply by arranging a time for the proper Agent to be running; or everyone can send to the sole Agent owner in the group (the sysop), running Agent at pre-specified hours.

The workgroup can be a pair of composers or two hundred people swapping Mirage samples statewide. It simply depends on the imagination of the humans involved.

THE CLEVER COURIER, THE ARTFUL AGENT

Courier supports only Xmodem (error-free) transfers. (The Xmodem or Xmodem/CRC protocol sends blocks of data, then checks each block to see if it was received correctly.) The error-checking slows things down a bit, and the user has to back out when the transfer is over; operation is anything but automatic. Ditto on upload. Files arrive with icon and name intact, so you always get or send a complete, ready-to-go file. Unlike general-purpose telcom applications Red Ryder or MockTerminal, Courier contacts *only* MUG Safehouses or personal Agents. This tradeoff peels away layers of complication and frustration. Mismatched protocols are virtually impossible. Agent, the friendly minihost, answers calls, accepts incoming file *Drops*, and offers the caller outbound files. (Version 1.1 of the shareware has a 50-file maximum; register and you get an upgrade holding 100 outbound goodies.) To begin, set up two folders or volumes and open Agent. It's that simple. You don't even have to be home: Agent maintains an activity list for you.

Depending on how the Agent is set up (see below) it can be a workgroup-net node, or a BBS for a Mac-oriented business (put a Courier with the phone number onto your product diskette) or a specialized special-interest group, like maybe, New Yorkers Who Swap Sound Designer Files for the Emulator. Even networking within the same building (from Studio A to Sound Room C) is as cheap as it gets if you already have phone lines and modems.



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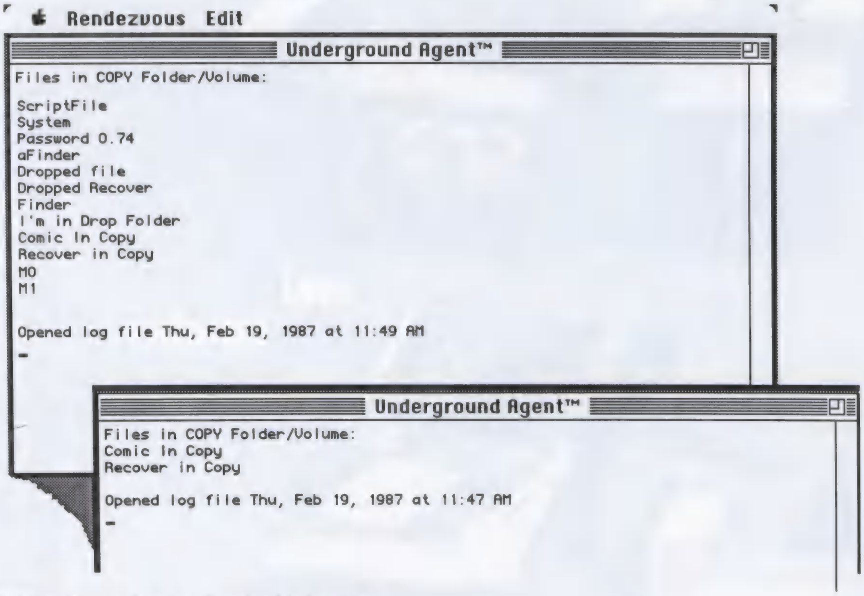
SPEED: 1200
DISK: (•|•)
ROOM: 615K

"A&F Review • Jul '87.Film" This Months A&F Review in µFilm Format
SIZE: 91K UPDATED: 6/30/87

Fig. 1 *Window in Agent.*



```
Files in COPY Folder/Volume:

ScriptFile
System
Password 0.74
aFinder
Dropped file
Dropped Recover
Finder
I'm in Drop Folder
Comic In Copy
Recover in Copy
MO
M1


Opened log file Thu, Feb 19, 1987 at 11:49 AM
-
```

```
Files in COPY Folder/Volume:
Comic In Copy
Recover in Copy

Opened log file Thu, Feb 19, 1987 at 11:47 AM
-
```

Fig. 2 *Screen showing download information.*

You can find a demo of Courier on GEnie, PAN, a BBS, or get it from a friend (awwwright...or send me an SASE with $0.37 postage on it and a 3½-inch disk initialized for Macintosh and be prepared to wait a while to receive it). It's fully functional except for a full-access Underground password. (A personal Agent doesn't need passwords.) It gets you a Safehouse for a test drive. If you like what you see, buy Agent and go.

The Courier menu bar at the top of the Mac's screen contains the Mac Apple, Mission, Archive and Drop menus. Mission corresponds to the usual File menu, and you can set up things within about 45 seconds in five simple moves. *Drop* sends a File or Message. The Message window is a simple text editor for "post-it notes" to the host. *File* opens the usual Mac file-select window—double-click to Open a file as with any Mac application. Click Drop to send it, Cancel to change your mind.

'CHIVIN & JIVIN'

Under *Archives* you see a host's file categories. There are about 20 Safehouse categories like *Desk Accessories*, *Artwork*, *News Briefs*, *Fonts* and so on. Select one; the familiar window opens after a short pause (**Fig. 1**). Choose a file. Courier (**Fig. 2**) shows its size and estimated download time so you can decide whether to download, and if so direct it to the proper disk.

Click *Copy to Disk*. Transfer begins; an update materializes. The Mac beeps when it's over and the select window reappears. You may choose more in that window or

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The music industry chose the Ensoniq ESQ-1 as the Most Innovative Keyboard of 1987 ...over the Yamaha DX7II, the Roland D-50 and Korg DSS-1

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ensoniq
1987
MUSIC & SOUND
Award
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There are good reasons why the ESQ-1 is at the head of the keyboard class. First there's sound—always the top criteria in evaluating a musical instrument. The ESQ's 3 digital oscillators per voice and choice of 32 different waveforms give you an unmatched pallette of tone colors.

If you'd rather just plug it in and play, there are thousands of great sounds available on cartridge, cassette and disk from Ensoniq and a number of other sound developers.

The ESQ-1 is also the only synth in its class to feature an on-board 8 track MIDI sequencer with functions that rival many stand-alone units. And because the ESQ-1 is multi-timbral with dynamic voice allocation, it can play a completely different 8-voice sound on each sequencer track.

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move to another Archive by returning to the menu. An Agent's Archives holds the Copy Folder. Its window shows all accessible files. Believe me, it took longer to read this than it does to run Courier.

It's nice having a smart Mac ready when those Opcode Patch Librarian and Sequencer files are coming via Ma Bell sometime in the night. I've used Courier-Agent for articles and art. Works great. What about sending files from home to the studio or office? They'll be there whenever anyone needs them next, and:

✓ No cost for a pay-per-minute computer service! No file-storage charges!
✓ Only Courier users, with your number, can access Agent.
✓ Encrypt critical files with PackIt III.
✓ No waiting around to answer the phone.
✓ Error-free file transfers.
✓ Two-minute Agent setup; one-minute Courier log on.

OPERATIONAL DETAILS IN SHORT

As mentioned previously, up to 50 files may be located in the folder with Agent 1.1, and up to 100 with the upgraded Agent sent to you in return for your shareware payment.

Agent can be configured in two ways. The first allows access to an entire diskette for all callers, and subsequent callers can get files earlier callers have left. Use this when three or four people collaborating on a project need to get the newest updates. The potential for sharing work files among people across a city, a state, or the country—in fields other than music, too—is astonishing. I do suggest a 2400 Baud modem, though, to keep the data zipping along at a suitably high-tech rate.

The second configuration prevents callers from copying dropped files—only the contents of *copy* may download. *Drop* is for your eyes only. Neat, huh?

Agent works with hard disks, and B,W&A does not copy-protect. A Courier 1.21 password Demo is available on GEnie (#4453) and PAN, not CompuServe. Agent is on GEnie as well. A version of Courier is also on "Wisconsin Safehouse," one of the many bulletin board nodes in MacUnderground. This is a Demo with short-term full privileges: "Wisconsin Safehouse" GEnie #4439. MacUnderground membership, disk and documentation and password from Buck, Wheat and Associates, $29.95. **EM**

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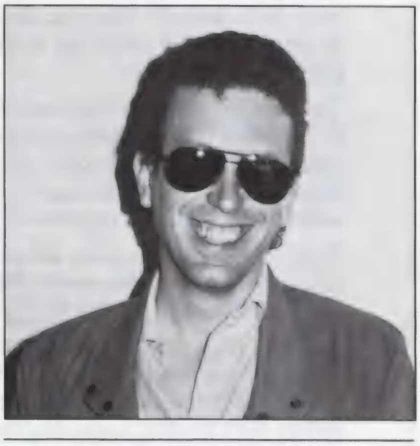

Craig O'Donnell, widely published musical electronics/computer author and OPtion magazine's technical editor, just received an MBA from Northwestern and became involved in two start-up export businesses—Style Music Group and Royal Software. He plans "to become the T. Boone Pickens of synthesizers: exercise well-financed hostile takeovers of Roland, Yamaha and E-mu; form MIDI—Monopoly In Digital Instruments Corporation; then raise prices."

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Music Notation in ASCII

BY LEIGH ANN HUSSEY

You are corresponding with a friend over an electronic bulletin board system, and you want to send him a song you're composing on your sequencer, but the machines and software at each end are different. What do you do?

You might conclude that musicians who correspond over the likes of computer networks and bulletin board systems have no way to communicate written music to each other. Some of us have the benefit of a Macintosh or one of the other machines with nice music notation software, but even this software is useless with a BBS machine that understands only ASCII characters. Even encoding programs such as binhex (Mac), ARC (IBM) or uuencode (Unix) require both the uploader and the downloader to have not only the same *encoding* software, but the same *music* software. The future may bring a standard sequencer file format that will work with any notation program, but the people at both ends still would need either a MIDI instrument or a music notation program. Faced with this situation, if you *still* want to send your song to a friend, you're going to have to invent your own system of computer-communicable music notation. That's exactly what I did, and I'd like to share it (ASCIMUS) with the **EM** readership.

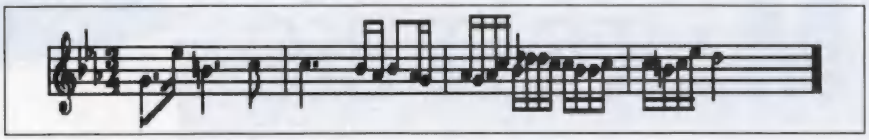


Fig. 1 *Example musical phrase*

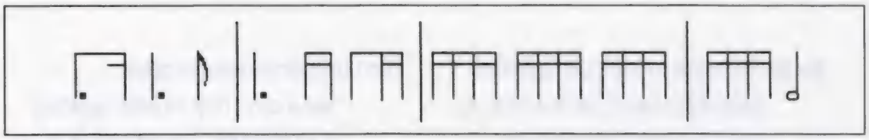


Fig. 2 *Transcription of rhythm only*

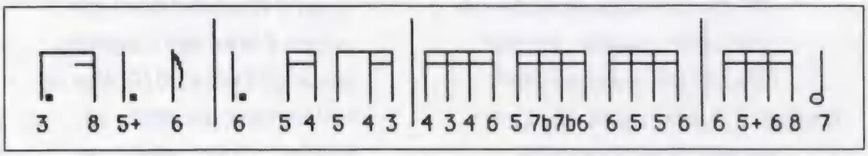


Fig. 3 *Assigning note values*

There are three big advantages to my system: the only hardware you'll need will be the computer you use to phone your bulletin board system; a human being can read the notation without using any software at all; and it's free.

In a Basic Musicianship course I took at the University of California at Berkeley, I learned that a first step in learning to transcribe music from dictation is to take down only the rhythms. This concept helped solve the music telecommunications problem. For example, **Fig. 2** is a transcription of only the rhythm from the phrase in **Fig. 1**. At school we would go on from there to apply notes on a staff to the rhythms. I found myself needing a system to take down snatches of my own

***Leigh Ann Hussey** received her BA in music from UC Berkeley, sings, writes poetry and music and plays 14 instruments. She is working on a cassette of instrumental pieces—inspired by deities of various cultures—using electronic instruments (Macintosh) and ethnic instruments of the cultures in question. She writes fantasy fiction, is married, and lives in Berkeley.*

tunes when they came up and no staff-paper was handy. For that I used another technique I learned: assigning numbers to the tones of a scale: Do = 1; Re = 2; etc.—and writing them under the rhythm notation. See **Fig. 3**.

At this point, translating my musical shorthand to ASCII was fairly simple. Rhythmic and other elements translate as you see in **Fig. 4**. If you want to attach an eighth to a 16th (as in **Fig. 5**), you can use a dash instead of an underscore for the eighth note. Both the natural sign and the 16th-note use the equal sign, but the contexts are sufficiently different that there should be no confusion.

MOVABLE VERSUS FIXED

Since people tend to sing the songs passed around on the BBS in the most comfortable key anyway, the *movable Do* system is especially useful. In movable Do, minor relationships are signified by 3- or *3b* (for "3 flat"). The insertion of a major (such as in a "Picardy Third" cadence) would be signified by 3× or *3#*. On the other hand, a fixed system, where numbers one to seven mark the notes A to F, is better if you're transmitting complicated music filled with modulations and the like.

If more than one octave is involved, 1′ to 7′ signify the respective notes one octave above the median Do (or middle C, if you use the fixed system, where middle C is indicated by one of the numbers from 1 to 7 depending on the key); 1″ to 7″ signify two octaves above; ′1 to ′7 signify one octave below; and ″1 to ″7 two octaves below. The key signature is in English, placed wherever it's convenient. For the movable system, a simple "major" or "minor" will do; for the fixed, the full "F-sharp major" or "A-flat minor" is necessary. Bar lines are also written with the horizontal bar. **Fig. 5** shows how you can use underscore for slurs and add words to make a fifth line.

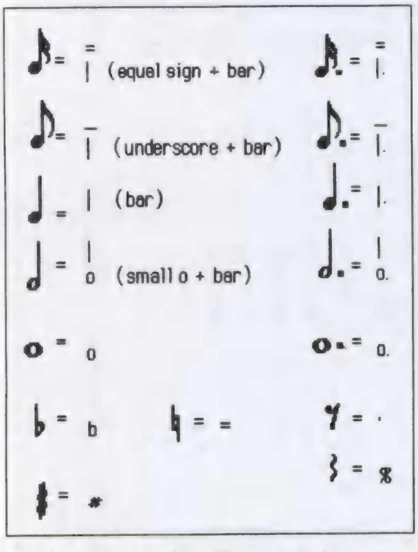


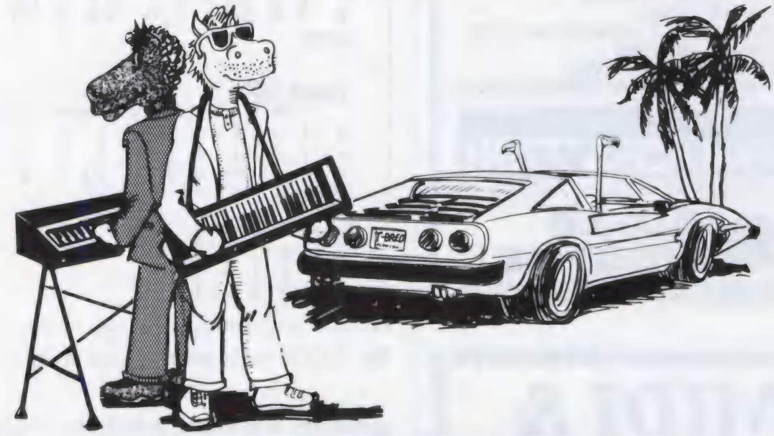
Fig. 4 *Conversion chart for musical elements*

In its final form, one line of music takes four lines of ASCII to transmit. Therefore, **Fig. 1** would be translated to ASCII as **Fig. 6** demonstrates.

RANDOM THOUGHTS

Notice that this system only works if your printer uses a mono-spaced font, as opposed to proportional spacing. Since most terminals use mono-spaced fonts, it shouldn't be a problem. I find the movable Do easier to work with. It can be sung more immediately, since the fixed system must be translated to music first unless you have perfect pitch, which most of us don't.

Some limitations remain, primarily



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```
major              |             |                 |         |
4   |   |   |   |  |  |   |   |  |  |   |   |   |  |  |   |  |
-   |   |   |   |  |  |   |   o  |  |   |   |   |  |  o   o  |
4   1   3   5   5  |  5   4   3  |  5   5   6   4  |  5   3  |
     Bacche, be-ne   ve - ni- es  gra-tus  et  op - ta - tus

               |         ___     |                 |         |
|   |   |   |  |  |   |  | |  |  |  |   |   |   |  |  |   |  |
|   |   |   |  |  |   |  | |  |  |  |   |   |   |  |  o   o  |
1   2   3   2  |  4   3  3_2__3  |  3   4   2   1  |  2   1  |
per quem noster  a - ni-mus       fit  le-ti - fi - ca - tus!
```

Fig. 5 *ASCII transcription examples*

Movable Do:

```
    --==      _ |      ===  ---===  | =======  =======  =======  | =======
3   |  |  |   | |  |   | |  |   | | | | | | |  | | | |  | | | |  | | | | |  |
-   |. |  |.  | |  |.  | |  |   | | | | | | |  | | | |  | | | |  | | | | |  o
4   3  8  5+  6 |  6   5 4  5   4 3 | 4 3 4 6  5 7b7b6  6 5 5 6  | 6 5+6 8  7+
minor
```

Fixed Do:

```
    --==         _ |       =====    ----==== | ==========  ==========  ========== |
3   |  |   |     | |  |    |   |    |    | | | |  |  |  |  |  |  |  |  |  |  |  |  |
-   |. |   |.    | |  |.   |   |    |    | | | |  |  |  |  |  |  |  |  |  |  |  |  |
4   7  5'  2'=   3'|  3'   2'b 1'   2'   1' 7| 1' 7  1' 3' 3' 4'b4'b3' 3' 2' 2' 3' |
Eb minor

==========      |
|  |  |  |  |   |
|  |  |  |  o   |
3' 2'=3' 5' 4=  |
```

Fig. 6 *ASCII transcription of phrase in Fig. 1*

in the area of notating polyphony. Nonetheless, while this system may be a little pedestrian, once you know the small handful of correspondences, it isn't hard to read, and it will be a pleasant change of pace for EM readers to have to spend nothing but a little time on a handy computer tool.

(The author wishes to thank Josh Gordon and "Shadowthought" of Thelema-Net BBS for assistance in the development of ASCIMUS.) **EM**

This is a Test

Can you recognize these fragments? If you can figure out the tunes from which the following fragments were taken, you've already learned ASCIMUS.

Test 1.

```
maj   _   _  |  _______  _  |   _   _  |    .    |
6   | | | |  |  | | |  | |  |  | | | |  |  |   |  |
-   | | | |  |  | | |  | |  |  | | | |  |  |.  |. |
8   1 1 2 2  |  3 4 3  1 '5 |  1 1 2 2  |  3   1  |
```

Test 2.

```
maj ========      |  ========  ========  |  ========     |
2   |  |  |  |  | |  |  |  | | | | | |   |  |  |  | | |  |
-   |  |  |  |  | |  |  |  | | | | | |   |  |  |  | | |  |
4   1 '7  1 '7  1 |  1 '7  1 2 3 2 3 4   |  5 4* 5 4*  5  |
```

Test 3.

```
maj  |      _  _______  |    ___  |      _______  |     ___    |
4  | |   |  |  |  |  | |  |  |  | |  | |  |  |  | |  |  |  | |  |
-  | |   o  |  |  |  | |  |  |  | |  | |. |  |  | |  |  |  | o  |
4  5 |   3___  3  5  6 |  2  2  3 |  4 1' 1' 7  5 |  6  5  4 3  |
```

(Answers: 1. "Pop Goes the Weasel" 2. Mozart, "Marriage of Figaro" Overture 3. "Hey Jude")

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Howard Cano's last **EM** *article,* Build the Alpha Digital Drum, *generated an unprecedented response from* **EM** *readers, all of whom wanted to see the followup . . . so here it is. If you're an advanced experimenter, get out those soldering irons and build . . .*

SAM:
A Simple Sound Sampler

BY HOWARD CANO

If you built the Alpha digital drum described in the February **EM**, or if you are just interested in digital sound sampling, SAM (short for "sampler") is for you. Simply, SAM is a microcomputer dedicated to converting rapidly changing voltages (such as audio signals) into a series of numbers, and storing them in memory. It then can transmit these numbers via an RS-232 link to a personal computer. In addition to its basic function, SAM's other features include four sampling speeds, expandable memory, and four Baud rates.

For those of you who need a monophonic sampler in audio applications, SAM will play the sample back through an amplification system. For those with oscilloscopes, it can serve as a waveform recorder to help observe non-repeating events such as turn-on transients.

Although SAM's design is about as simple as possible (if you had no problems with the Alpha drum, you should be able to handle SAM), you should be well-versed in electronics before you attempt construction. In addition, you'll need to know at least enough programming to write a routine to get the information from SAM into your PC. Properly programmed, SAM will dump its data through the RS-232 serial port on your particular personal computer. The choice of language is yours, but try to keep the routine short and fast, or it won't keep up with the data stream. SAM will dump at any of four Baud rates; choose the fastest one that your program will read reliably. This program naturally will be different for different computers.

SAM has no facilities to program EPROMs, since you'll want to load the data to your PC, edit it to remove noise and clicks (or perhaps splice the attack of one sound and the decay of another together for special effects), and store it to disk before "burning" (programming) a chip. Programmer cards that will burn your sample into an EPROM are available in the $60 range for anything from a Commodore to an IBM (check the computer mags). Of course, if you use SAM as a digital scope, no burning is needed.

CIRCUIT DESCRIPTION

Referring to **Fig. 1**, SAM's "brain" is a Z80A (IC1), one of the cheapest and most commonly available microproces-

Howard Cano*, an electronics engineer with experience in analog and digital design, has recently designed a 22-bit A/D converter. He has also manufactured several types of musical equipment. His hobbies include playing guitar and other instruments, flying radio-controlled airplanes, and driving red sports cars.*

sors. The 3.579 MHz crystal and a high-speed CMOS NAND gate (IC2A) generate the clock signal. A 74HC42 BCD-to-decimal decoder (IC3) selects the eight blocks of memory (up to 8K each) the processor can access. These are, in order:
1. The program EPROM (IC4);
2. The switches;
3. An Analog Devices AD7575 A/D converter (IC5);
4. A 74HC374 D/A converter (IC6) and its R2R ladder;
5-8. At least one, but up to four, 6264 CMOS RAMs (IC7-10).

SAM can use from one to four 6264s, depending on your budget (they cost about $5 each). The printed circuit layout (see **Figs. 2a** and **2b** for component legend and foil side artwork) has room for only one, but additional RAMs can be

Parts List

Resistors *(¼W 5% unless noted otherwise)*

R1, R2, R8, R17	1M
R3, R7, R9, R15, R16	2k2 (2.2k)
R4	4M7 (4.7 Meg)
R5, R6, R11	330 Ohm
R10	10k
R12	1M 1%
R13, R14, R19-R43	162k 1%
R18	47k
RP1	10k resistor pack, 10 lead, common to Pin 1

Capacitors *(all capacitors 16 WVDC or greater)*

C1, C2, C10	100 pF 10% tolerance
C3, C5, C6, C12-C14	1μ tantalum capacitor, -20/+80% tolerance or better
C4, C9, C11, C15-C21	100 nF (0.1 μF), -20/+80% tolerance or better
C7	4n7 (4700 pF) 10% tolerance
C8	220 pF 10% tolerance

Semiconductors

D1-12	1N914/1N4148 general purpose silicon diode
IC1	Z80A (4 MHz) microprocessor
IC2	74HC00 quad NAND gate
IC3	74HC42 decimal decoder
IC4	2732 4K X 8 EPROM
IC5	AD7575 A/D converter
IC6	74HC374 octal D-type flip-flop
IC7-10	6264 8K X 8 CMOS RAM
IC11	TL084 quad bifet op amp
IC12	7805 +5V regulator
LED1-LED3	General purpose LED
Q1	2N3906 PNP transistor

Other Parts

XTL1	3.579545 MHz crystal
B1	Two 1.5V AA alkaline batteries
Misc.	Sockets, circuit board, wire, solder, etc.

The following items are available from Howard Cano: Programmed 2732 EPROM ($5), etched and drilled printed circuit board ($15), and A7575 A/D converter IC ($15). Mail your check or money order to Howard Cano, 6747 Quail St., Arvada, CO 80004. (Editor's note: *please allow* ***six to eight weeks*** *for delivery. Howard Cano does not operate a large mail-order house, but is an individual who offers these parts as a service to* **EM** *readers and therefore cannot always fill orders instantaneously.*)

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added by a number of methods. (See "Construction Notes," below.) Two alkaline AA cells make the RAM nonvolatile. Transistor Q1 monitors the positive supply and disables the 6264s when power is removed. IC11, a TL084 quad op amp, serves as the RS-232 level shifter (IC11A), analog voltage reference (IC11B), peak record indicator (IC11C), and input buffer (IC11D). R18/C8 and R16/C7 attenuate high frequencies from the input signal to prevent aliasing. The cutoff frequency is appropriate for the fastest sample speed (50 kHz), so additional filtering may be necessary when using slower sample speeds.

Two of the NAND gates (IC2B and IC2C) form a flip-flop for the RS-232 output, and the last gate (IC2D) is a WRITE indicator buffer. The A/D converter is an Analog Devices AD7575, a wonderful IC that has a successive approximation converter, sample/hold amplifier, voltage reference, and tri-state output latch all included! SAM would be much more complex if all these functions had to be accomplished with separate chips.

SOFTWARE

SAM's program (**Fig. 3**) looks a little funny for several reasons. First, I wanted to save all of the RAM for the recorded sound. Since calling subroutines requires a stack,

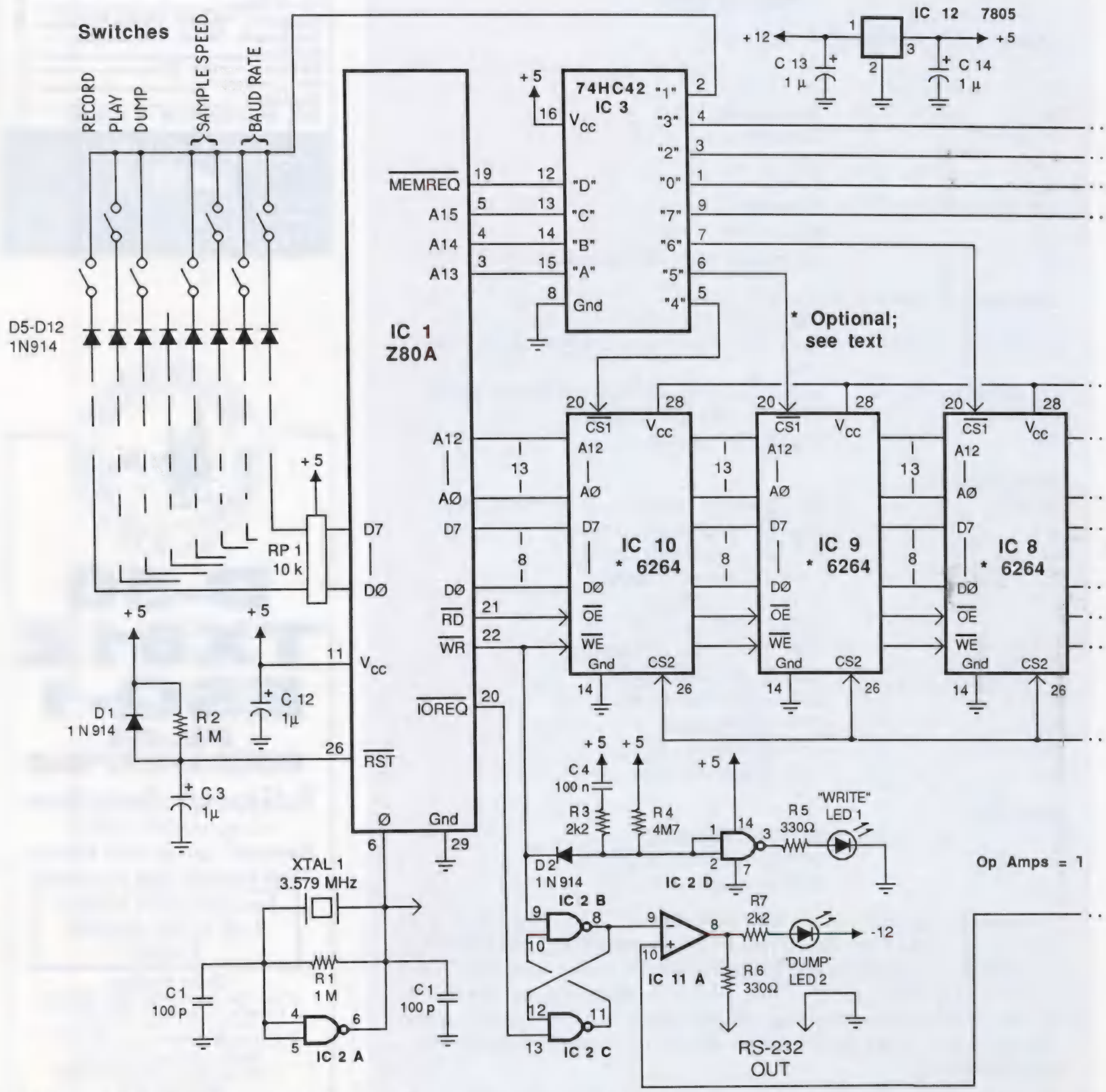

Switches
RECORD
PLAY
DUMP
SAMPLE SPEED
BAUD RATE
D5-D12
1N914
RP 1
10 k
+5
D1
1N914
R 2
1 M
C 12
1µ
C 3
1µ
IC 1
Z80A
MEMREQ
A15
A14
A13
A12
AØ
D7
DØ
RD
WR
IOREQ
RST
Vcc
Ø
Gnd
XTAL 1
3.579 MHz
R 1
1 M
C 1
100 p
IC 2 A
74HC42
IC 3
"D"
"C"
"B"
"A"
"0"
"1"
"2"
"3"
"4"
"5"
"6"
"7"
* Optional;
see text
IC 10
* 6264
IC 9
* 6264
IC 8
* 6264
CS1
CS2
OE
WE
13
8
IC 12 7805
+12
+5
C 13
1 µ
C 14
1 µ
C 4
100 n
R 3
2k2
R 4
4M7
D2
1N914
IC 2 B
IC 2 C
IC 2 D
R 5
330Ω
"WRITE"
LED 1
R7
2k2
R 6
330Ω
'DUMP'
LED 2
IC 11 A
-12
RS-232
OUT
Op Amps = 1

Fig. 1 *Schematic diagram for SAM.* **Note:** This schematic spans pages 82 and 83; the dotted lines between the two pages should connect.

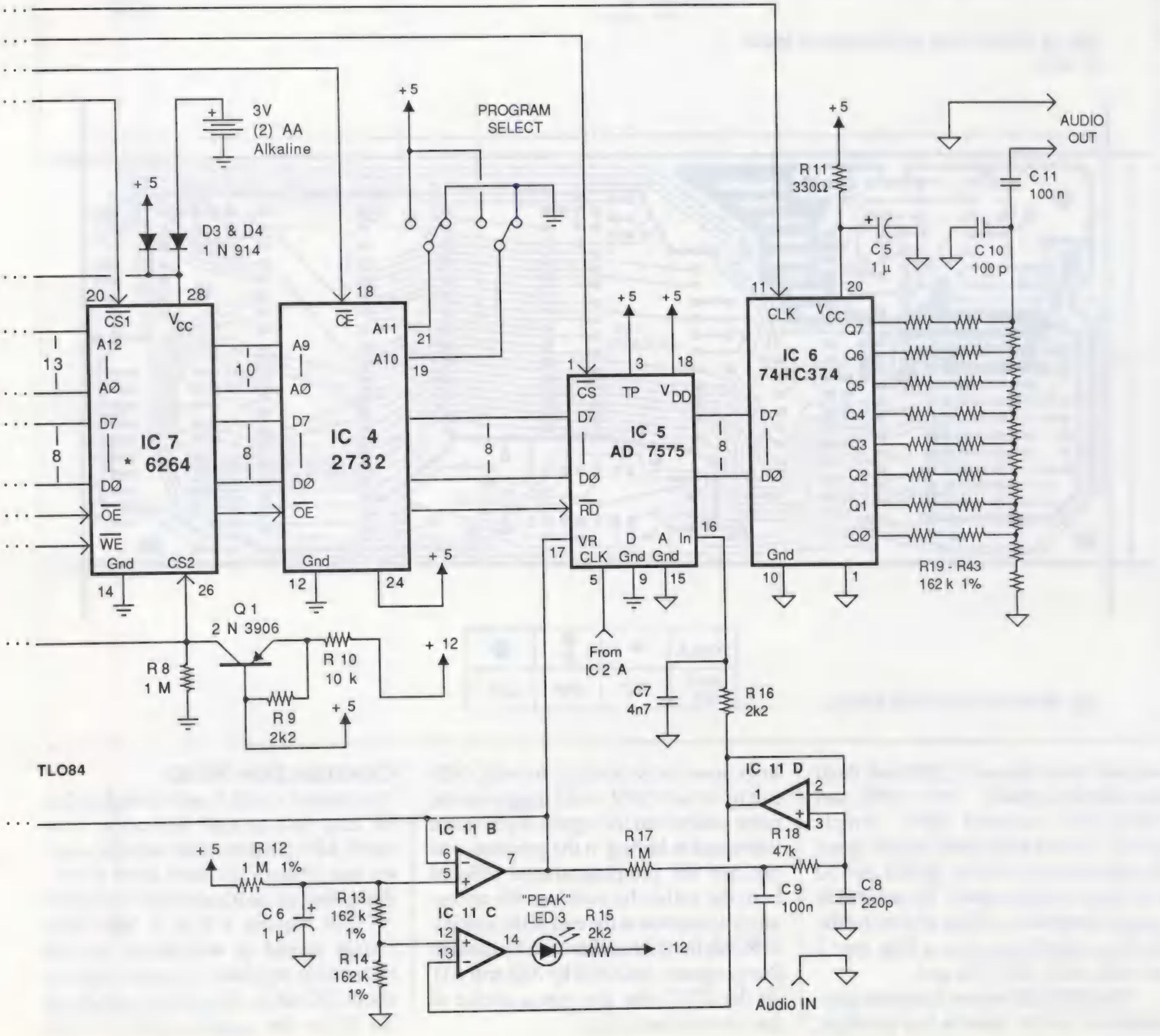
and the stack for the Z80 is in RAM, I used no subroutines. Fortunately, the blocks of the program which are used frequently are short, and (using a word processor) it was a simple matter to copy them to any place they were needed. This is essentially what a macro assembler would do, but my assembler won't macro. Second, since the Z80 has no internal hardware provisions for serial I/O, all RS-232 timing is done in software. This necessitates timed loops, a few NOPs, and some "do nothing" jumps. Still, even with all the repetition and strange programming methods, the program takes up less than one-tenth of the EPROM.

The program documentation is fairly self-explanatory. The MAIN PROGRAM scans the record, play, and dump switches, and jumps to the appropriate routine when a switch is pressed. The RECORD routine waits for the sample data to move more than ± 1 count (TRIGGER), then samples at the appropriate speed. PLAY recalls the sound and sends it to the D/A. DUMP sends the sample data down the RS-232 output line. The Baud rate switches are scanned once in DUMP, and the sample speed switches are scanned at the beginning of RECORD or PLAY. Different combinations of switches give different Baud rates and sample speeds;

SAM Sound Sampler

All resistors = 1/4 W. 5% except as noted.

Op Amp supply = ± 12 V ~ C 15—21 = 100 n


3V
(2) AA
Alkaline
+ 5
PROGRAM
SELECT
D3 & D4
1 N 914
IC 7
* 6264
CS1
Vcc
A12
AØ
D7
DØ
OE
WE
Gnd
CS2
20
28
14
26
13
8
10
IC 4
2732
OE
A11
A10
A9
18
21
19
12
24
IC 5
AD 7575
CS
TP
VDD
RD
VR
CLK
D Gnd
A Gnd
In
1
3
18
17
5
9
15
16
From
IC 2 A
IC 6
74HC374
CLK
Q7
Q6
Q5
Q4
Q3
Q2
Q1
QØ
11
20
10
R 11
330Ω
C 5
1 µ
C 10
100 p
C 11
100 n
AUDIO
OUT
R19 - R43
162 k 1%
Q 1
2 N 3906
R 8
1 M
R 10
10 k
R 9
2k2
+ 12
TLO84
C7
4n7
R 16
2k2
IC 11 D
IC 11 B
IC 11 C
R 17
1 M
R 18
47k
C 9
100n
C 8
220p
R 12
1 M 1%
C 6
1 µ
R 13
162 k
1%
R 14
162 k
1%
"PEAK"
LED 3
R 15
2k2
- 12
Audio IN

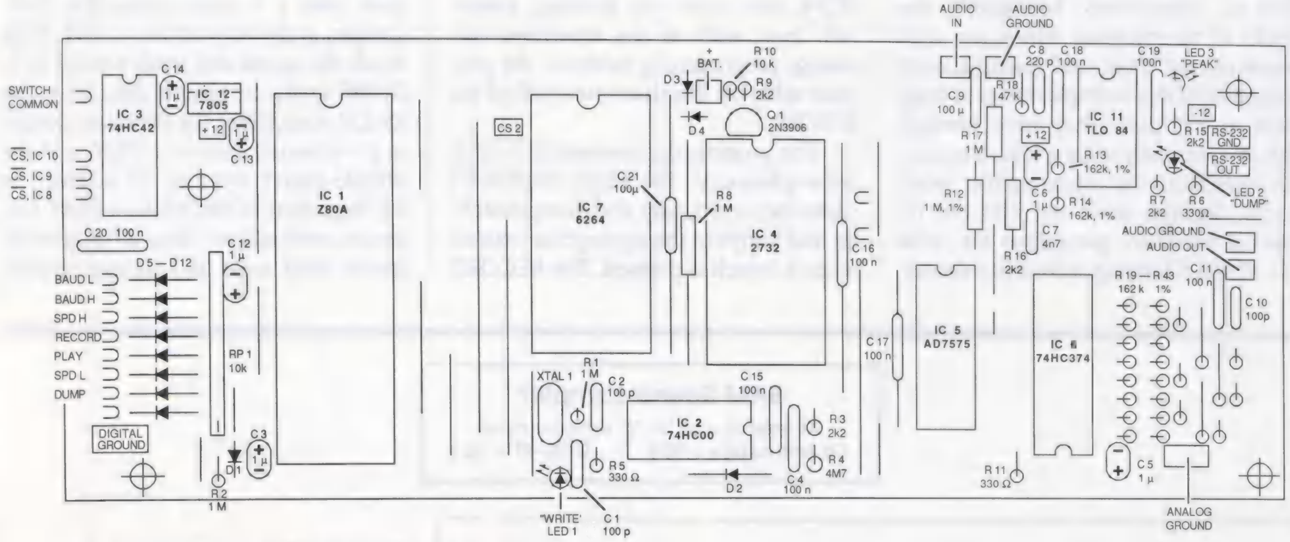
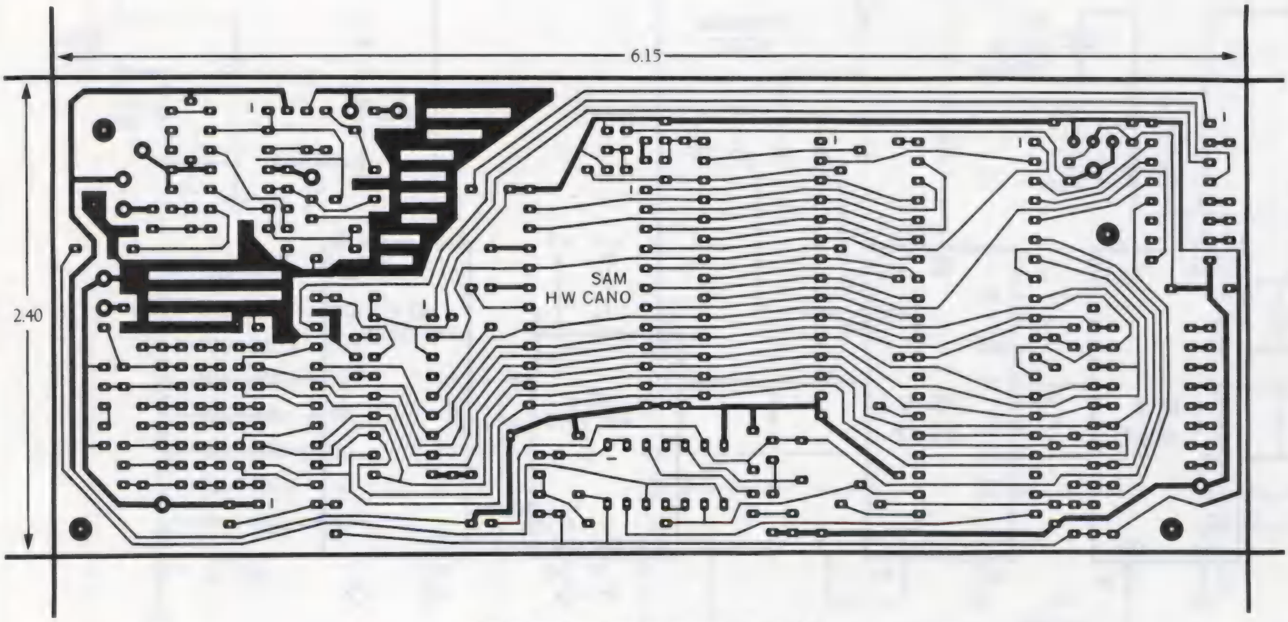

SWITCH COMMON
$\overline{CS}$, IC 10
$\overline{CS}$, IC 9
$\overline{CS}$, IC 8
C 14
1 µ
IC 12
7805
IC 3
74HC42
+12
1 µ
C 13
IC 1
Z80A
C 20 100 n
C 12
1 µ
D 5 — D 12
BAUD L
BAUD H
SPD H
RECORD
PLAY
SPD L
DUMP
RP 1
10k
DIGITAL GROUND
C3
1 µ
D1
R2
1 M
CS 2
+ BAT.
D3
R 10
10 k
R 9
2k2
D 4
Q 1
2N3906
C 21
100µ
IC 7
6264
R 8
1 M
IC 4
2732
C 16
100 n
C 17
100 n
XTAL 1
R1
1 M
C2
100 p
C 15
100 n
IC 2
74HC00
R3
2k2
R4
4M7
R5
330 Ω
D2
C4
100 n
"WRITE" LED 1
C 1
100 p
AUDIO IN
AUDIO GROUND
C 8
220 p
C 18
100 n
C 19
100n
LED 3
"PEAK"
C 9
100 µ
R 18
47 k
R 17
1 M
IC 11
TLO 84
-12
R 15
2k2
RS-232 GND
RS-232 OUT
+12
R 13
162k, 1%
R12
1 M, 1%
C 6
1 µ
R 14
162k, 1%
R 7
2k2
R 6
330Ω
LED 2
"DUMP"
C 7
4n7
AUDIO GROUND
AUDIO OUT
R 16
2k2
IC 5
AD7575
R 19 — R 43
162 k 1%
C 11
100 n
C 10
100p
IC 6
74HC374
R 11
330 Ω
C 5
1 µ
ANALOG GROUND

Fig. 2a *Printed circuit board component layout for SAM.*


6.15
2.40
SAM
HW CANO

SYMBOL	▪	○ ○	●
HOLE SIZE	.031″	.043″	.125″

Fig. 2b *Printed circuit board foil side.*

available Baud rates are 1,200 (both Baud rate switches closed), 2,400, 4,800, and 9,600 (both switches open). Sample speeds are 10.8 kHz (both sample speed switches closed), 18 kHz, 30 kHz, and 50 kHz (both switches open). These provide sample lengths from about 650 ms (at the 50 kHz sampling rate) to a little over 3 seconds at the 10.8 kHz rate.

The TRIGGER routine has some comments on how to make it less sensitive, since some noisy sources are very difficult to record (SAM could trigger on the noise rather than the signal). If you're not interested in keying in the program, you can buy the pre-programmed EPROM from the author by mail (see the necessary information at the end of the article). EPROMs from the author actually contain *four* programs (selected by A10 and A11 on the 2732) that give you a choice of four levels of sensitivity.

CONSTRUCTION NOTES

The printed circuit board is single-sided for easy do-it-yourself fabrication, so it needs a few jumpers. Make sure the jumpers and bypass caps don't short to anything. Also, all the ICs should be socketed.

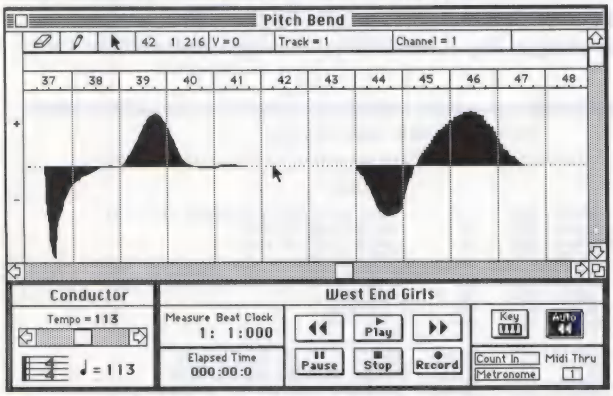
SAM requires ± 9 to 15 Volts. This voltage should be well-filtered but not necessarily regulated. Current drain is about 200 mA on the positive supply and 20 mA on the negative. IC12, a 5-Volt

The INTERFACE
A Newsletter for the Passport User Network

Vol. 2 Number 5 Passport Designs, Inc. 625 Miramontes St. Half Moon Bay, Ca. 94019 Autumn 1987

Editor's Notes
by Brent Silveria

Master Tracks Pro Makes the Move



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Master Tricks
By Denis Labrecque

Cosmic Clocks etc.

In this issue I would like to pass on a few tips on composing in Northern California with the help of harmonic convergence and Master Tracks Pro for the Mac & Atari........

Interesting new rhythms can be created on a track by using the Humanize feature to "drop" some notes out of a file. First select a highly velocity-sensitive patch on your synthesizer, then input a series of sixteenth notes with the Step Editor (set all velocities to a value of 60). You can now "Humanize" the velocity of the track to a value of 60 - this will randomize the original velocity of 60 to + and - 60, causing some of the notes to have an effective velocity of zero. The resulting track will now have a totally new feel from your original track. (If some of the notes are now too loud you can further modify the track by reducing all the velocities by a percentage with the Edit Velocity dialog.)

Another method of creating new rhythms with the Step Editor is to use the Keyboard mapping dialog (under the Goodies Menu) to allow you to control note durations with your master keyboard . Set the keyboard to "map" some notes in the lower portion of the keyboard, allowing your left hand to change durations. If you "play" with both hands, your left hand will be changing durations while only your right hand will be inputting notes - resulting in some pretty strange and interesting tracks.

Here's a tip from our West coast rep Greg Lee. You can change a chord progression from a Major Key to a Minor Key (or vice/versa) by using the Strip Data and Transpose Commands. Record a chord progression in C then set the Strip Data dialog to cut and paste just single notes (the notes "E", "A" and "B" in this case) to separate tracks. Next use the mix Data feature to combine these notes to a single track.Then just transpose the resulting track down a half step and play it with the original track(s) to hear your piece in a minor key. You can even Copy this track and switch back and forth between the Major and Minor on playback.

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on-board regulator, powers the digital circuitry; heatsinking is required for the regulator.

Grounding is always important, but this is even more critical when analog and digital circuitry co-exists on the same board. Run separate grounds for the analog and digital circuitry, and connect these together at the power supply ground only. On the schematic, digital grounds are represented by conventional three-line ground symbols; analog grounds are represented by a triangular outline. Pay very special attention to the routing and shielding of wires; microcomputers (like the digital section of SAM) generate large amounts of noise which can adversely affect analog circuitry.

If you want more memory, wire all the pins on your additional 6264s in parallel with those on IC7, except for pin 20 (CS1 bar). Pin 20 on each extra 6264 connects to its appropriate bank select pin on IC3 (74HC42). Add memory starting with IC8, progressing toward IC10. For a neat assembly, you might want to make a sep-

```
                         ;       SAM 2   Z-80 BASED SAMPLING SYSTEM
                         ;
                         ;*************************************************************
                         ;
                         ;                        CONSTANTS:
                         ;
0011                     SSDLY1  EQU     17      ;DELAY VALUE FOR SLOW SAMPLE (10.8 KHz)
0009                     SSDLY2  EQU     9       ;MEDIUM SLOW (18 KHz)
0004                     SSDLY3  EQU     4       ;MEDIUM FAST (30 KHz)
0001                     SSDLY4  EQU     1       ;FAST (50 KHz)
                         ;
0013                     BAUD96  EQU     19      ;DELAY VALUE FOR 9600 BAUD RS-232 OUT
002A                     BAUD48  EQU     42      ;4800 BAUD
0059                     BAUD24  EQU     89      ;2400 BAUD
00B6                     BAUD12  EQU     182     ;1200 BAUD
                         ;
2000                     SWTCHS  EQU     2000H   ;MEMORY LOCATION FOR SWITCHES
4000                     ADLOC   EQU     4000H   ;MEMORY LOCATION FOR A/D READ
6000                     DALOC   EQU     6000H   ;MEMORY LOCATION FOR D/A WRITE
8000                     RAMBTM  EQU     8000H   ;BOTTOM OF RAM IN FULLY LOADED SYSTEM
                         ;
                         ;*************************************************************
                         ;
                         ;                        REGISTERS:
                         ;
                         ;       REG.    FUNCTION                ROUTINE
                         ;       ----    --------                -------
                         ;
                         ;       B       SAMPLE SPEED DELAY      GETSPD, REC, PLAY
                         ;
                         ;               BAUD RATE DELAY         DUMP, IO
                         ;
                         ;
                         ;       C       DELAY COUNTER           TRIG, REC, PLAY, IO
                         ;
                         ;
                         ;       D       FIRST A/D READING       TRIG
                         ;
                         ;               BIT COUNTER             IO
                         ;
                         ;
                         ;       E       DATA BYTE               DUMP, IO
                         ;
                         ;
                         ;       H       RAM POINTER, HIGH BYTE  ALL
                         ;
                         ;
                         ;       L       RAM POINTER, LOW BYTE   ALL
                         ;
                         ;*************************************************************
                         ;
                         ;                        MAIN PROGRAM
                         ;
0000                             ORG     0
                         ;
                         ;"INITIALIZE" LOADS DEFAULT VALUES
                         ;
0000  32  00  00         INIT    LD      (0),A            ;SET RS-232 OUTPUT TO MARK
0003  3E  7F                     LD      A,127            ;SET D/A OUTPUT TO
0005  32  00  60                 LD      (DALOC),A        ; 127 (HALFWAY UP)
                         ;
                         ;END INITIALIZE
                         ;
                         ;
                         ;"MAIN" SCANS RECORD, PLAY, AND DUMP SWITCHES,
                         ;    TAKES APPROPRIATE ACTION
                         ;
0008  3A  00  20         MAIN    LD      A,(SWTCHS)       ;SWITCH STATUS TO ACCUMULATOR
000B  CB  47                     BIT     0,A              ;RECORD SWITCH CLOSED?
000D  CA  1D  00                 JP      Z,TRIG           ;IF SO, GO TO TRIGGER ROUTINE
0010  CB  4F                     BIT     1,A              ;PLAY SWITCH CLOSED?
0012  CA  9A  00                 JP      Z,PLAY           ;IF SO, GO TO PLAY ROUTINE
0015  CB  57                     BIT     2,A              ;DUMP SWITCH CLOSED?
0017  CA  D7  00                 JP      Z,DUMP           ;IF SO, GO TO DUMP ROUTINE
001A  C3  08  00                 JP      MAIN             ;DO IT ALL AGAIN
                         ;
                         ;               END MAIN PROGRAM
                         ;
                         ;*************************************************************
                         ;
                         ;                        ROUTINES
                         ;
                         ;"TRIGGER" LOOKS FOR BEGINNING OF SOUND,
                         ;       THEN GOES TO RECORD
                         ;
001D                     TRIG
                         ;
                         ;       "FIND RAM" LOCATES ACTUAL BOTTOM OF SYSTEM RAM,
                         ;       EXITS WITH RESULTS IN HL
                         ;
001D  31  00  20         FNDRMA  LD      SP,2000H         ;DISPLACEMENT BETWEEN RAM BLOCKS
0020  21  00  60                 LD      HL,RAMBTM-2000H  ;START AT
0023  39                 FNDRM1A ADD     HL,SP            ; RAM BOTTOM
0024  7E                         LD      A,(HL)           ;READ DATA
```

Fig. 3 *Program listing for the software in EPROM.*

```
0025  34                    INC     (HL)              ;ADD ONE AT RAM LOCATION
0026  BE                    CP      (HL)              ;HAS DATA CHANGED? (IS RAM PRESENT?)
0027  28  FA                JR      Z,FNDRM1A         ;IF NOT, GO TO NEXT RAM BLOCK
0029  77                    LD      (HL),A            ;ELSE PUT DATA BACK
002A  31  00  00            LD      SP,0000H          ; AND CLEAR STACK POINTER
                    ;                         HL NOW CONTAINS THE ADDRESS OF THE ACTUAL
                    ;                         BOTTOM OF RAM
                    ;
                    ;       END FIND RAM
                    ;
                    ;
                    ;       "GET SPEED" SCANS SAMPLE SPEED SWITCHES, EXITS
                    ;       WITH APPROPRIATE DELAY VALUE IN B
                    ;
002D  3A  00  20    GTSPDA  LD      A,(SWTCHS)        ;SWITCH STATUS TO ACCUMULATOR
0030  E6  30                AND     00110000B         ;MASK FOR SAMPLE SPEED
0032  20  02                JR      NZ,GTSPD1A        ;SLOW SAMPLE? IF NOT, GO TO GETSPD1
0034  06  11                LD      B,SSDLY1          ;ELSE LOAD SPEED REG WITH SLOW DELAY
0036  FE  10        GTSPD1A CP      00010000B         ;MEDIUM SLOW SAMPLE?
0038  20  02                JR      NZ,GTSPD2A        ;IF NOT, GO TO GETSPD2
003A  06  09                LD      B,SSDLY2          ;ELSE LOAD SPEED REG WITH MED SLOW
003C  FE  20        GTSPD2A CP      00100000B         ;MEDIUM FAST SAMPLE?
003E  20  02                JR      NZ,GTSPD3A        ;IF NOT, GO TO GETSPD3
0040  06  04                LD      B,SSDLY3          ;ELSE LOAD SPEED REG WITH MED FAST
0042  FE  30        GTSPD3A CP      00110000B         ;FAST SAMPLE?
0044  20  02                JR      NZ,GTSPD4A        ;IF NOT, GO TO GETSPD4
0046  06  01                LD      B,SSDLY4          ;ELSE LOAD SPEED REG WITH FAST
0048                GTSPD4A
                    ;
                    ;       END GET SPEED
                    ;
                    ;
0048  3A  00  40            LD      A,(ADLOC)         ;START FIRST CONVERSION- DATA
004B                                                  ; AVAILABLE NEXT TIME AROUND
004B  0E  04                LD      C,4               ;DELAY VALUE FOR TRIG READS
004D  0D            TRIG1   DEC     C                 ;DELAY LOOP
004E  20  FD                JR      NZ,TRIG1
0050  3A  00  40            LD      A,(ADLOC)         ;GET FIRST A/D READING
0053  57                    LD      D,A               ;SAVE IT
                    ;ADD ONE OR TWO "SRL D" INSTRUCTIONS HERE TO MAKE TRIG LESS SENSITIVE
0054  0E  01        TRIG2   LD      C,1               ;WASTE TIME SO THAT
0056  0D                    DEC     C                 ; EACH PATH BELOW HAS
0057  20  FB                JR      NZ,TRIG2          ; SAME TIME DELAY
0059  0E  01        TRIG3   LD      C,1
005B  0D                    DEC     C
005C  20  FB                JR      NZ,TRIG3
005E  32  00  00    TRIG4   LD      (0),A             ;TOGGLE WRITE LINE TO LIGHT LED
0061  3A  00  40            LD      A,(ADLOC)         ;GET NEW READING
                    ;ADD ONE OR TWO "SRL A" INSTRUCTIONS HERE TO MAKE TRIG LESS SENSITIVE
0064  BA                    CP      D                 ;SAME AS FIRST READING?
0065  28  ED                JR      Z,TRIG2           ;IF SO, LOOP TO TRIG2
0067  C6  01                ADD     A,1               ;ADD ONE TO NEW READING
0069  BA                    CP      D                 ;READINGS NOW EQUAL?
006A  28  ED                JR      Z,TRIG3           ;IF SO, LOOP TO TRIG3
006C  D6  02                SUB     2                 ;SUBTRACT ONE FROM NEW READING
006E  BA                    CP      D                 ;READINGS NOW EQUAL?
006F  28  ED                JR      Z,TRIG4           ;IF SO, LOOP TO TRIG4
0071                                                  ;ELSE GO TO RECORD ROUTINE
                    ;
                    ;END TRIGGER
                    ;
                    ;
                    ;"RECORD" SAVES A/D CONVERSIONS TO RAM
                    ;
0071  48            RECORD  LD      C,B               ;SAMPLE SPEED DELAY TO COUNTER
0072  3A  00  40            LD      A,(ADLOC)         ;GET DATA FROM A/D
0075  77                    LD      (HL),A            ;SAVE DATA TO RAM
0076  00                    NOP
0077  00                    NOP
0078  0D            REC1    DEC     C                 ;DELAY LOOP
0079  20  FD                JR      NZ,REC1
007B  23                    INC     HL                ;NEXT RAM LOCATION
007C  ED  7A                ADC     HL,SP             ;REACHED TOP OF RAM?
007E  20  F1                JR      NZ,RECORD         ;IF NOT, CONTINUE
0080                                                  ;ELSE STORE 127 AT FIRST
0080                                                  ; AND LAST RAM LOCATIONS
                    ;
                    ;       "FIND RAM" LOCATES ACTUAL BOTTOM OF SYSTEM RAM,
                    ;       EXITS WITH RESULTS IN HL
                    ;
0080  31  00  20    FNDRMB  LD      SP,2000H          ;DISPLACEMENT BETWEEN RAM BLOCKS
0083  21  00  60            LD      HL,RAMBTM-2000H ;START AT
0086  39            FNDRM1B ADD     HL,SP             ; RAM BOTTOM
0087  7E                    LD      A,(HL)            ;READ DATA
0088  34                    INC     (HL)              ;ADD ONE AT RAM LOCATION
0089  BE                    CP      (HL)              ;HAS DATA CHANGED? (IS RAM PRESENT?)
008A  28  FA                JR      Z,FNDRM1B         ;IF NOT, GO TO NEXT RAM BLOCK
008C  77                    LD      (HL),A            ;ELSE PUT DATA BACK
008D  31  00  00            LD      SP,0000H          ; AND CLEAR STACK POINTER
                    ;                         HL NOW CONTAINS THE ADDRESS OF THE ACTUAL
                    ;                         BOTTOM OF RAM
                    ;
                    ;       END FIND RAM
                    ;
                    ;
0090  36  7F                LD      (HL),127          ;127 INTO FIRST RAM LOCATION
0092  21  FF  FF            LD      HL,0FFFFH         ;127 INTO LAST
0095  36  7F                LD      (HL),127          ; RAM LOCATION
0097  C3  08  00            JP      MAIN              ;RETURN TO MAIN
                    ;
                    ;END RECORD
                    ;
                    ;
                    ;"PLAY" RETRIEVES SAMPLED SOUND FROM MEMORY, SENDS TO D/A
                    ;
009A                PLAY
                    ;
                    ;       "FIND RAM" LOCATES ACTUAL BOTTOM OF SYSTEM RAM,
                    ;       EXITS WITH RESULTS IN HL
                    ;
009A  31  00  20    FNDRMC  LD      SP,2000H          ;DISPLACEMENT BETWEEN RAM BLOCKS
009D  21  00  60            LD      HL,RAMBTM-2000H ;START AT
00A0  39            FNDRM1C ADD     HL,SP             ; RAM BOTTOM
00A1  7E                    LD      A,(HL)            ;READ DATA
00A2  34                    INC     (HL)              ;ADD ONE AT RAM LOCATION
00A3  BE                    CP      (HL)              ;HAS DATA CHANGED? (IS RAM PRESENT?)
00A4  28  FA                JR      Z,FNDRM1C         ;IF NOT, GO TO NEXT RAM BLOCK
00A6  77                    LD      (HL),A            ;ELSE PUT DATA BACK
00A7  31  00  00            LD      SP,0000H          ; AND CLEAR STACK POINTER
                    ;                         HL NOW CONTAINS THE ADDRESS OF THE ACTUAL
                    ;                         BOTTOM OF RAM
                    ;
                    ;       END FIND RAM
                    ;
                    ;       "GET SPEED" SCANS SAMPLE SPEED SWITCHES, EXITS
                    ;       WITH APPROPRIATE DELAY VALUE IN B
```

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arate board that accommodates all four memory chips, and use a DIP header to connect the memory expansion board to the main board via IC7's socket.

USING SAM

The audio input has a minimum 47k Ohm input impedance and accepts a 2.5 Volt peak-to-peak signal (0.85 Volts RMS), so most line-level sources should work fine. Microphones, guitar pickups, and other low-level or high-output-impedance devices will require preamplification.

Remember, noise can cause SAM to trigger before the beginning of a sound. I find it helpful to use a reel-to-reel recorder to tape sounds at 15 ips, and splice leader tape right up to the first attack. This makes level setting easier too. If the trigger is too sensitive, try switching to a less sensitive program (accessed from pins A10 and A11 on the EPROM).

```
                          ;
00AA  3A  00  20          GTSPDB  LD     A,(SWTCHS)        ;SWITCH STATUS TO ACCUMULATOR
00AD  E6  30                      AND    00110000B         ;MASK FOR SAMPLE SPEED
00AF  20  02                      JR     NZ,GTSPD1B        ;SLOW SAMPLE? IF NOT, GO TO GETSPD1
00B1  06  11                      LD     B,SSDLY1          ;ELSE LOAD SPEED REG WITH SLOW DELAY
00B3  FE  10              GTSPD1B CP     00010000B         ;MEDIUM SLOW SAMPLE?
00B5  20  02                      JR     NZ,GTSPD2B        ;IF NOT, GO TO GETSPD2
00B7  06  09                      LD     B,SSDLY2          ;ELSE LOAD SPEED REG WITH MED SLOW
00B9  FE  20              GTSPD2B CP     00100000B         ;MEDIUM FAST SAMPLE?
00BB  20  02                      JR     NZ,GTSPD3B        ;IF NOT, GO TO GETSPD3
00BD  06  04                      LD     B,SSDLY3          ;ELSE LOAD SPEED REG WITH MED FAST
00BF  FE  30              GTSPD3B CP     00110000B         ;FAST SAMPLE?
00C1  20  02                      JR     NZ,GTSPD4B        ;IF NOT, GO TO GETSPD4
00C3  06  01                      LD     B,SSDLY4          ;ELSE LOAD SPEED REG WITH FAST
00C5                      GTSPD4B
                          ;
                          ;       END GET SPEED
                          ;
                          ;
00C5  48                  PLAY1   LD     C,B               ;SPEED DELAY INTO COUNTER
00C6  7E                          LD     A,(HL)            ;GET DATA FROM RAM
00C7  32  00  60                  LD     (DALOC),A         ;SEND TO D/A
00CA  00                          NOP
00CB  00                          NOP
00CC  0D                  PLAY2   DEC    C                 ;DELAY LOOP
00CD  20  FD                      JR     NZ,PLAY2
00CF  23                          INC    HL                ;NEXT MEMORY LOCATION
00D0  ED  7A                      ADC    HL,SP             ;REACHED TOP OF MEMORY?
00D2  20  F1                      JR     NZ,PLAY1          ;IF NOT, CONTINUE
00D4  C3  08  00                  JP     MAIN              ;ELSE END PLAY, RETURN TO
00D7                                                       ; MAIN
                          ;END PLAY
                          ;
                          ;
                          ;"DUMP" RETRIEVES DATA FROM RAM, SENDS TO RS-232 OUT
                          ;
00D7  3A  00  20          DUMP    LD     A,(SWTCHS)        ;SWITCH STATUS TO ACCUMULATOR
00DA  E6  C0                      AND    11000000B         ;MASK FOR BAUD RATE
00DC  20  02                      JR     NZ,DUMP1          ;1200 BAUD? IF NOT, GO TO DUMP1
00DE  06  B6                      LD     B,BAUD12          ;ELSE LOAD RATE REG WITH 1200 DELAY
00E0  FE  40              DUMP1   CP     01000000B         ;2400 BAUD?
00E2  20  02                      JR     NZ,DUMP2          ;IF NOT, GO TO DUMP2
00E4  06  59                      LD     B,BAUD24          ;ELSE LOAD RATE REG WITH 2400
00E6  FE  80              DUMP2   CP     10000000B         ;4800 BAUD?
00E8  20  02                      JR     NZ,DUMP3          ;IF NOT, GO TO DUMP3
00EA  06  2A                      LD     B,BAUD48          ;ELSE LOAD RATE REG WITH 4800
00EC  FE  C0              DUMP3   CP     11000000B         ;9600 BAUD?
00EE  20  02                      JR     NZ,DUMP4          ;IF NOT, GO TO DUMP4
00F0  06  13                      LD     B,BAUD96          ;ELSE LOAD RATE REG WITH 9600
00F2                      DUMP4
                          ;
                          ;       "FIND RAM" LOCATES ACTUAL BOTTOM OF SYSTEM RAM,
                          ;       EXITS WITH RESULTS IN HL
00F2  31  00  20          FNDRMD  LD     SP,2000H          ;DISPLACEMENT BETWEEN RAM BLOCKS
00F5  21  00  60                  LD     HL,RAMBTM-2000H ;START AT
00F8  39                  FNDRM1D ADD    HL,SP             ; RAM BOTTOM
00F9  7E                          LD     A,(HL)            ;READ DATA
00FA  34                          INC    (HL)              ;ADD ONE AT RAM LOCATION
00FB  BE                          CP     (HL)              ;HAS DATA CHANGED? (IS RAM PRESENT?)
00FC  28  FA                      JR     Z,FNDRM1D         ;IF NOT, GO TO NEXT RAM BLOCK
00FE  77                          LD     (HL),A            ;ELSE PUT DATA BACK
00FF  31  00  00                  LD     SP,0000H          ; AND CLEAR STACK POINTER
                          ;                    HL NOW CONTAINS THE ADDRESS OF THE ACTUAL
                          ;                    BOTTOM OF RAM
                          ;
                          ;       END FIND RAM
                          ;
                          ;
0102  5C                          LD     E,H               ;SEND DATA IN H (SIZE OF RAM)
                          ;
                          ;
                          ;       "I/O" HANDLES PARALLEL TO SERIAL CONVERSION, START AND
                          ;       STOP BIT GENERATION, TIMING
                          ;
0103  ED  78              IOA     IN     A,(C)             ;INITIATE START PULSE
0105  00                          NOP                      ; BY TOGGLING IOREQ' LINE
0106  00                          NOP                      ; TO GIVE SPACE (VALUES IN
0107  00                          NOP                      ; A AND C NOT IMPORTANT)
0108  48                          LD     C,B               ;I/O DELAY TO COUNTER
0109  0D                  IO1A    DEC    C                 ;DELAY LOOP
010A  20  FD                      JR     NZ,IO1A
010C  16  0A                      LD     D,10              ;DO 8 DATA AND 2 STOP BITS
010E  48                  IO2A    LD     C,B               ;I/O DELAY TO COUNTER
010F  00                          NOP
0110  00                          NOP
0111  37                          SCF
0112  CB  1B                      RR     E                 ;LSB = 0 ?
0114  30  06                      JR     NC,IO3A           ;IF SO, GO TO IO3
0116  00                          NOP                      ;ELSE WRITE A MARK
0117  32  00  00                  LD     (0),A             ; (VALUE IN A UNIMPORTANT)
011A  18  05                      JR     IO4A              ;AND GO TO IO4
011C  ED  78              IO3A    IN     A,(C)             ;TOGGLE IOREQ' TO GIVE SPACE
011E  00                          NOP
011F  00                          NOP
0120  00                          NOP
0121  0D                  IO4A    DEC    C                 ;DELAY LOOP
0122  20  FD                      JR     NZ,IO4A
0124  15                          DEC    D                 ;DONE FOR 10 BITS?
0125  20  E7                      JR     NZ,IO2A           ;IF NOT, LOOP
0127                                                       ;ELSE END I/O
```

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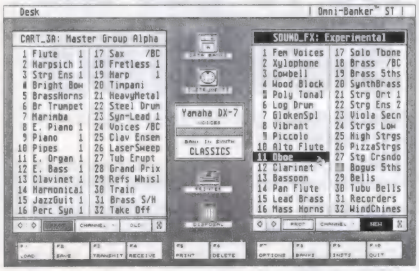

CART_3A: Master Group Alpha
1 Flute 1
2 Harpsich 1
3 Strg Ens 1
4 Bright Bow
5 BrassHorns
6 Br Trumpet
7 Marimba
8 E. Piano 1
9 Piano 1
10 Pipes 1
11 E. Organ 1
12 E. Bass 1
13 Clavinet 1
14 Harmonical
15 JazzGuit 1
16 Perc Syn 1
17 Sax /BC
18 Fretless 1
19 Harp 1
20 Timpani
21 HeavyMetal
22 Steel Drum
23 Syn-Lead 1
24 Voices /BC
25 Clav Ensem
26 LaserSweep
27 Tub Erupt
28 Grand Prix
29 Refs Whisl
30 Train
31 Brass S/H
32 Take Off

SOUND_FX: Experimental
1 Fem Voices
2 Xylophone
3 Cowbell
4 Wood Block
5 Poly Tonal
6 Log Drum
7 GlokenSpl
8 Vibrant
9 Piccolo
10 Alto Flute
11 Oboe
12 Clarinet
13 Bassoon
14 Pan Flute
15 Lead Brass
16 Mass Horns
17 Solo Tbone
18 Brass /BC
19 Brass 5ths
20 SynthBrass
21 Strg Ort 1
22 Strg Ens 2
23 Viola Secn
24 Strgs Low
25 High Strgs
26 PizzaStrgs
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```
                                   ;
                                   ;       END I/O
                                   ;
                                   ;
    0127  5E                       DUMP5   LD      E,(HL)          ;GET DATA
                                   ;
                                   ;       "I/O" HANDLES PARALLEL TO SERIAL CONVERSION, START AND
                                   ;       STOP BIT GENERATION, TIMING
                                   ;
    0128  ED  78                   IOB     IN      A,(C)           ;INITIATE START PULSE
    012A  00                               NOP                     ; BY TOGGLING IOREQ' LINE
    012B  00                               NOP                     ; TO GIVE SPACE (VALUES IN
    012C  00                               NOP                     ; A AND C NOT IMPORTANT)
    012D  48                               LD      C,B             ;I/O DELAY TO COUNTER
    012E  0D                       IO1B    DEC     C               ;DELAY LOOP
    012F  20  FD                           JR      NZ,IO1B
    0131  16  0A                           LD      D,10            ;DO 8 DATA AND 2 STOP BITS
    0133  48                       IO2B    LD      C,B             ;I/O DELAY TO COUNTER
    0134  00                               NOP
    0135  00                               NOP
    0136  37                               SCF
    0137  CB  1B                           RR      E               ;LSB = 0 ?
    0139  30  06                           JR      NC,IO3B         ;IF SO, GO TO IO3
    013B  00                               NOP                     ;ELSE WRITE A MARK
    013C  32  00  00                       LD      (0),A           ; (VALUE IN A UNIMPORTANT)
    013F  18  05                           JR      IO4B            ;AND GO TO IO4
    0141  ED  78                   IO3B    IN      A,(C)           ;TOGGLE IOREQ' TO GIVE SPACE
    0143  00                               NOP
    0144  00                               NOP
    0145  00                               NOP
    0146  0D                       IO4B    DEC     C               ;DELAY LOOP
    0147  20  FD                           JR      NZ,IO4B
    0149  15                               DEC     D               ;DONE FOR 10 BITS?
    014A  20  E7                           JR      NZ,IO2B         ;IF NOT, LOOP
    014C                                                           ;ELSE END I/O
                                   ;
                                   ;       END I/O
                                   ;
                                   ;
    014C  23                               INC     HL              ;NEXT BYTE
    014D  ED  7A                           ADC     HL,SP           ;REACHED TOP OF RAM?
    014F  20  D6                           JR      NZ,DUMP5        ;IF NOT, LOOP
    0151  C3  08  00                       JP      MAIN            ;ELSE END DUMP,
    0154                                                           ; RETURN TO MAIN
                                   ;
                                   ;END DUMP
                                   ;
                                   ;
    0154                           END
0000   First word of program
0153   Last word of program
   0   Assembly errors
```

The peak indicator will help to set levels, and you can play back the sound to listen for unacceptable clipping or other problems. The audio output is 5 Volts peak-to-peak (1.75 Volts RMS) at 160k Ohms impedance. The output isn't intended to be studio quality, just good enough for monitoring. However, with this high an output impedance, you will probably want to add some kind of voltage follower or high-impedance buffer between the output and any subsequent audio input.

Generally, the 30 kHz sample speed will work fine. For sounds without much high-frequency content, a slower speed will permit longer samples in the same memory space, but for these you may need to low-pass filter the signal before it goes into SAM to prevent aliasing with the clock frequency.

RS-232 Output Format

SAM dumps its memory contents in binary (8 bits) with one start bit, two stop bits, and no parity. The first byte of each

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dump tells how much RAM is present (and the length of the dump). 80H indicates the full 32K RAM (four 6264s), A0H indicates 24K, C0H indicates 16K, and E0H indicates 8K (one 6264).

So there it is: a simple sampler for your Commodore 64. Good luck with your experiments and be sure to write to **EM** if you come up with any unusual applications or other ideas. **EM**

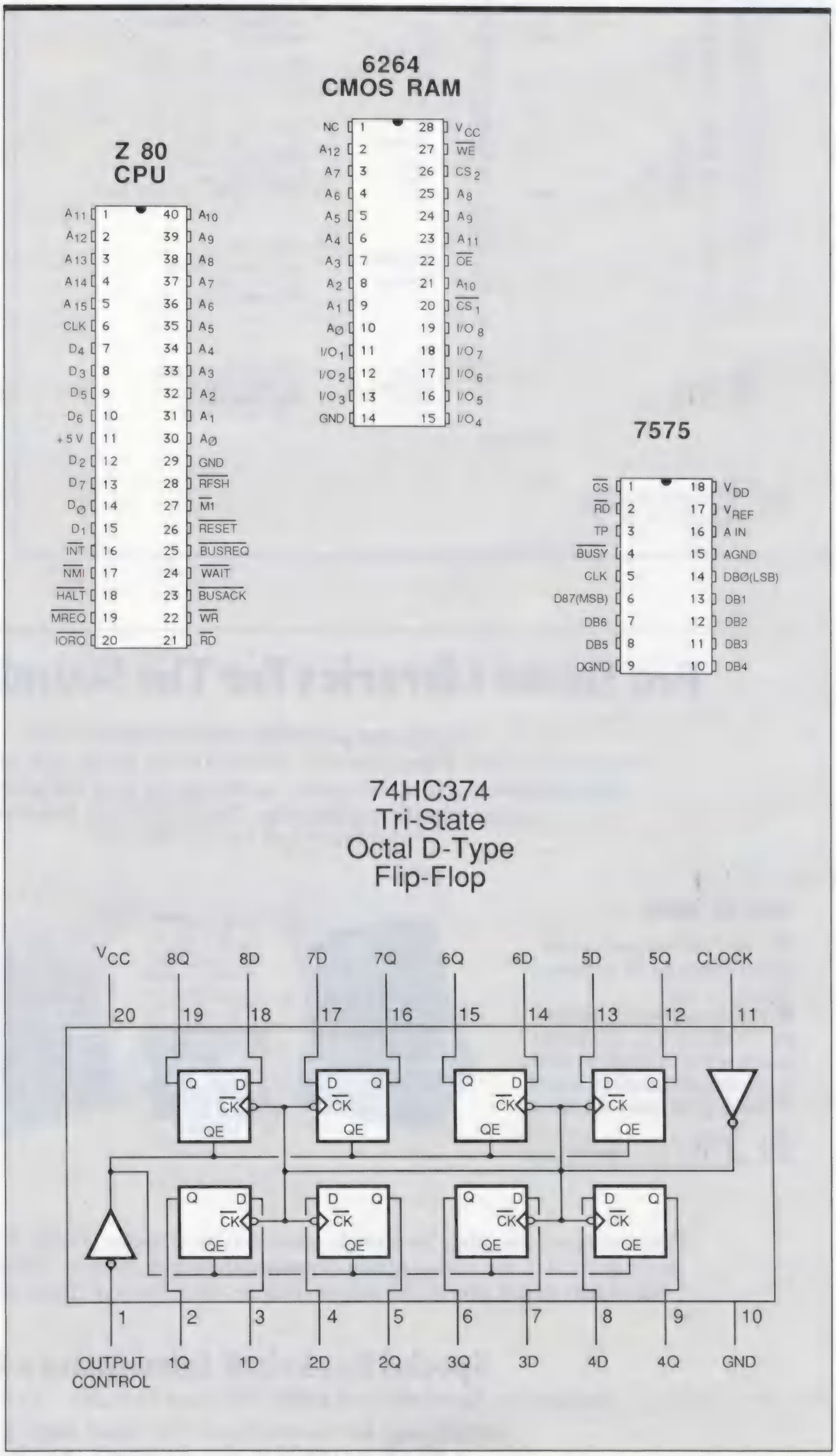
6264 CMOS RAM
NC 1
A12 2
A7 3
A6 4
A5 5
A4 6
A3 7
A2 8
A1 9
A0 10
I/O1 11
I/O2 12
I/O3 13
GND 14
28 VCC
27 WE
26 CS2
25 A8
24 A9
23 A11
22 OE
21 A10
20 CS1
19 I/O8
18 I/O7
17 I/O6
16 I/O5
15 I/O4
Z 80 CPU
A11 1
A12 2
A13 3
A14 4
A15 5
CLK 6
D4 7
D3 8
D5 9
D6 10
+5V 11
D2 12
D7 13
D0 14
D1 15
INT 16
NMI 17
HALT 18
MREQ 19
IORQ 20
40 A10
39 A9
38 A8
37 A7
36 A6
35 A5
34 A4
33 A3
32 A2
31 A1
30 A0
29 GND
28 RFSH
27 M1
26 RESET
25 BUSREQ
24 WAIT
23 BUSACK
22 WR
21 RD
7575
CS 1
RD 2
TP 3
BUSY 4
CLK 5
D87(MSB) 6
DB6 7
DB5 8
DGND 9
18 VDD
17 VREF
16 A IN
15 AGND
14 DB0(LSB)
13 DB1
12 DB2
11 DB3
10 DB4
74HC374 Tri-State Octal D-Type Flip-Flop
VCC 20
8Q 19
8D 18
7D 17
7Q 16
6Q 15
6D 14
5D 13
5Q 12
CLOCK 11
Q D CK QE
1 OUTPUT CONTROL
2 1Q
3 1D
4 2D
5 2Q
6 3Q
7 3D
8 4D
9 4Q
10 GND

Fig. 4 *IC pinouts for semiconductors used in SAM.*

Commodore-64 MIDI Software

SG-1 : Sound Generator Program

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- Allows any alternate tuning, mono or poly
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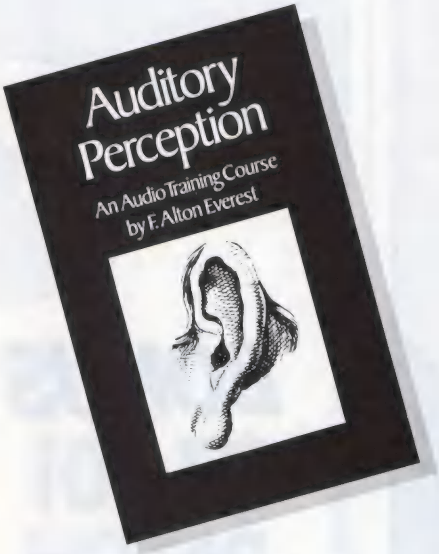

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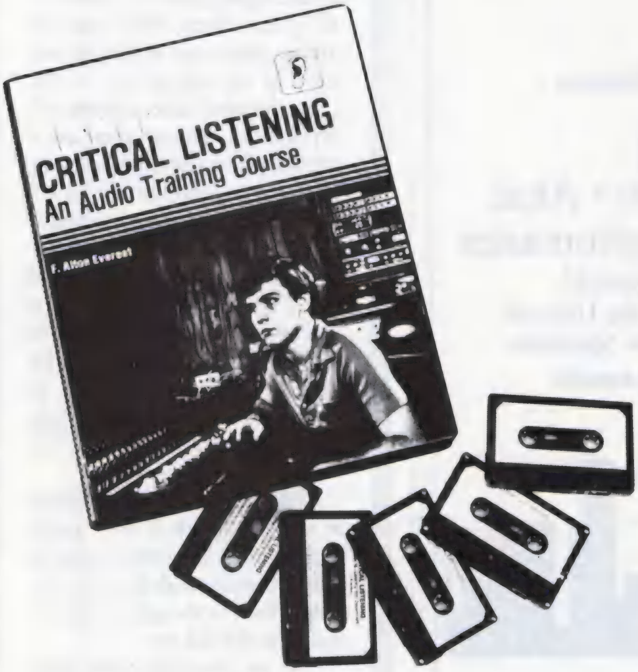

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You'll also note a little keyboard at the bottom left of each patch sheet for indicating which range of the keyboard sounds best with the patch. Yeah, we thought it was time someone did this too.

We are planning to run additional patch sheets for synths like the Xpander, K3, etc. Any suggestions? Do you like this idea? Let us know. *—Craig Anderton*

CZ101
SOUND DATA

TONE NAME	CART#	TONE#

PARAMETERS

LINE SEL	MODULATION		DETUNE				VIBRATO				OCT RANGE
	RING	NOISE	+/-	OCTAVE	NOTE	FINE	WAVE	DELAY	RATE	DEPTH	

LINE 1

DCO1 PITCH ENV

WAVE FORM								
STEP	1	2	3	4	5	6	7	8
RATE								
LEVEL								
S/E								

DCW1 WAVE ENV

KEY FOL								
STEP	1	2	3	4	5	6	7	8
RATE								
LEVEL								
S/E								

DCA1 AMP ENV

KEY FOL								
STEP	1	2	3	4	5	6	7	8
RATE								
LEVEL								
S/E								

LINE 2

DCO2 PITCH ENV

1	2	3	4	5	6	7	8

DCW2 WAVE ENV

1	2	3	4	5	6	7	8

DCA2 AMP ENV

1	2	3	4	5	6	7	8

RECOMMENDED KEYBOARD RANGE

NOTES

CZ101
SOUND DATA

TONE NAME	CART#	TONE#

PARAMETERS

LINE SEL	MODULATION		DETUNE				VIBRATO				OCT RANGE
	RING	NOISE	+/-	OCTAVE	NOTE	FINE	WAVE	DELAY	RATE	DEPTH	

LINE 1

DCO1 PITCH ENV

WAVE FORM								
STEP	1	2	3	4	5	6	7	8
RATE								
LEVEL								
S/E								

DCW1 WAVE ENV

KEY FOL								
STEP	1	2	3	4	5	6	7	8
RATE								
LEVEL								
S/E								

DCA1 AMP ENV

KEY FOL								
STEP	1	2	3	4	5	6	7	8
RATE								
LEVEL								
S/E								

LINE 2

DCO2 PITCH ENV

1	2	3	4	5	6	7	8

DCW2 WAVE ENV

1	2	3	4	5	6	7	8

DCA2 AMP ENV

1	2	3	4	5	6	7	8

RECOMMENDED KEYBOARD RANGE

NOTES

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Power: How to get it, how to use it, how to hold it. Best of all, how to suck it out of those funny little outlets on the wall and turn it into something you can use in an electronic music system.

Build a Bipolar Power Supply

BY THOMAS HENRY

Perhaps the most unglamorous module of any electronic system is the power supply; yet it also is one of the most important. A defective or inadequately designed power supply can cause hum, noise, and hash that can detract from the operation of even the best sound equipment, and possibly be detrimental to your health! So, even if the power supply is the wallflower of the music world, it behooves us all to pay serious attention to the design and implementation of power supplies.

This article describes how to build a bipolar power supply suitable for use in most any synthesis or electronic music system. The design is stable and easy to adapt to a variety of uses. In fact, I have six of these supplies in operation right now, in six completely different musical instruments, and they all work fabulously.

***Thomas Henry** played guitar professionally for ten years to put himself through school. Currently he is an assistant professor of computer science at Mankato State University in Minnesota. Aside from computers and electronics, Thomas has a passion for Victorian literature, Sherlock Holmes, and the works of Oscar Wilde.*

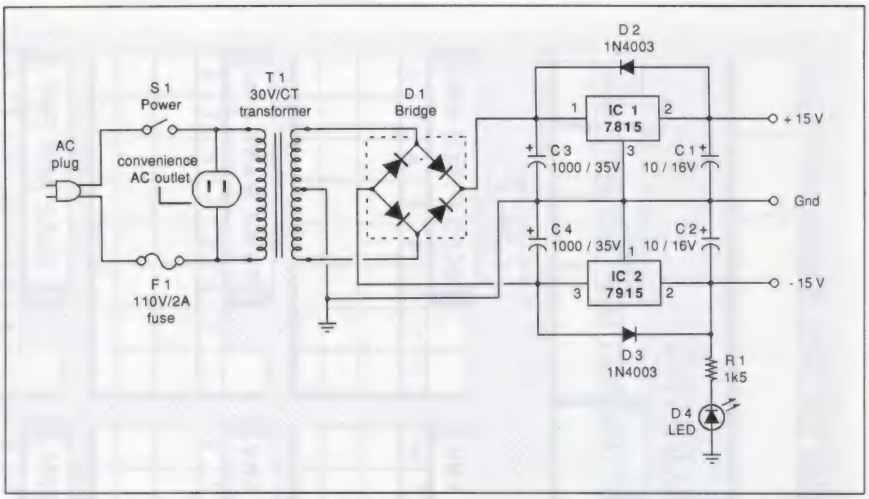

Fig. 1 *Bipolar power supply schematic.*

HOW IT WORKS

This power supply converts the 110V AC voltage from an ordinary wall socket into two voltages: +15 with respect to ground, and -15 with respect to ground. Because both positive and negative voltages are provided, this is a *bipolar* (as opposed to *unipolar*, which means having only one polarity) supply. (Other voltages can also be provided, as described later.) Referring to **Fig. 1**, transformer T1 steps down the AC voltage. Notice, however, that T1's primary is in series with a switch (for turning power on and off) and a 2 amp fuse. **Don't omit the fuse**, which is an important safety precaution; at the first sign of excessive current drain, it will open up and interrupt the flow of current from the wall socket.

Fig. 1 also shows an AC receptacle in parallel with T1. This is a so-called "convenience" outlet, which allows you to put another device under control of switch

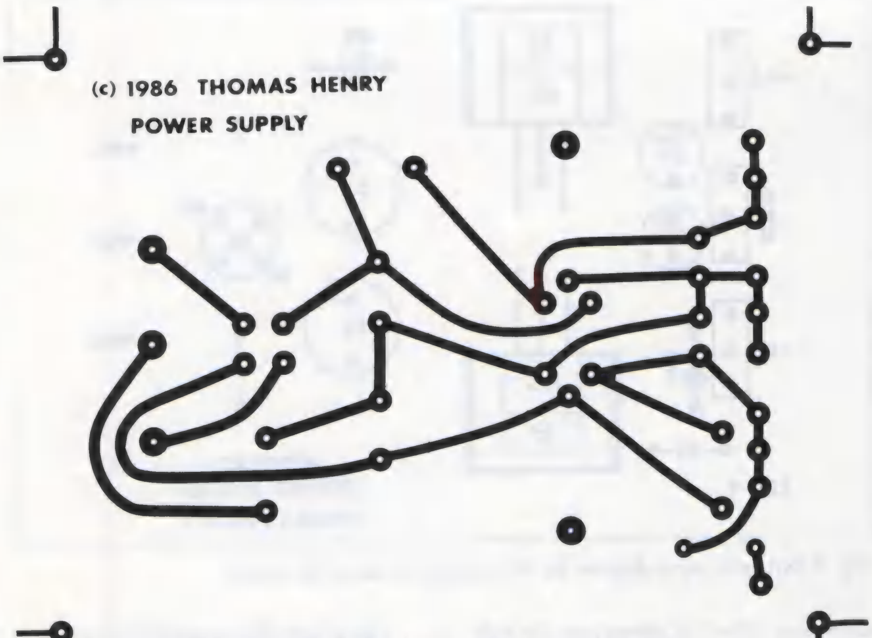

Fig. 2 *1:1 artwork for the foil side of the circuit board.*

S1. This should be a low-current device so as not to blow the fuse unnecessarily. This rules out lights, power amplifiers, and the like, but just about any other type of low current synthesis gear will work here. For example, I typically like to gang two modular units together (say a sequencer box and a drum machine), and control them with a single switch.

Okay, we've covered the 110V side of things; let's concentrate now on what happens beyond the secondary winding of transformer T1. T1 is specified as a 30V center-tapped type, capable of supplying 2 amps of current. This means that a voltage of 15V AC (RMS) is present across each outside leg of the secondary winding and the center tap. When stated as a peak-to-peak (p-p) instead of RMS voltage, this works out to about 21V p-p, which is just right for our purposes. The center tap provides the ground reference for the entire circuit; T1's two outside legs go to bridge rectifier D1, which converts the AC voltage to pulsating DC. D1 has two outputs; the one that connects to the anode of two diodes produces positive-going pulses, and the one that connects to the cathode of two diodes produces negative-going pulses.

Let's trace the positive side of the circuit. The pulsating DC voltage goes to capacitor C3, which smooths out the fluctuating voltage. The output at this point will be about 20V, and is a fairly smooth DC voltage. However, as load conditions increase, this voltage will decrease and the DC voltage will become less smooth. This is where voltage regulator IC1 comes into play; it clamps the output voltage at +15V, and holds that voltage regardless of any changes in load conditions. The result is a stable +15V DC source.

One very convenient feature of modern-day three-terminal regulators is that they are protected against output short circuits. If you short the output at pin 2 (see **Fig. 6**) directly to ground, IC1's internal circuitry will sense a rise in heat and automatically shut the regulator down until the overload is gone. Pretty magical! But a little-known fact is that most voltage regulators are not *input* short circuit-protected. In other words, if the input voltage at pin 1 falls below the voltage present at the output (pin 2), the regulator may be seriously damaged. This condition rarely occurs, but just in case it does, diode D2 provides the needed protection by zeroing out any dangerous voltage potential across pins 1 and 2.

Capacitor C1 helps to further stabilize the regulator, and also shunts any power supply noise to ground. The negative side of the power supply operates in a fashion analogous to the positive side just discussed; however, power-on indicator LED D4 gets its voltage from the negative side of the supply. (One possible modification would be to use a bi-color LED to monitor both sides of the supply.)

CONSTRUCTION

In the interests of safety, I urge you to use a properly laid-out printed circuit board. To ease the task of making the board, **Fig. 2** provides 1:1 artwork of the foil side of the board; **Fig. 3** shows the parts placement guide. Note that the transformer does not mount on the board, but solder holes are provided for connection to the transformer wires. **Caution!!** *The two holes marked AC connect to the low-voltage AC*

Parts List

Resistors *(¼ W, 5% preferred)*	
R1	1k5
Capacitors *(16 Working Volts DC or greater except as noted)*	
C1, C2	10 μF
C3, C4	1,000 μF electrolytic at 35 Volts
Semiconductors	
D1	Bridge rectifier, 50V/2 amps
D2, D3	1N4003 silicon diode
D4	Red LEDs
IC1	7815 positive 15 Volt regulator
IC2	7915 negative 15 Volt regulator
Mechanical Parts	
T1	110V to 30 VCT/2 amp transformer
F1	110V/2 amp fuse
S1	SPST switch rated at 115V/10 amps
Misc.	Case, hookup wire with plug, heatsinks, line cord, convenience outlet, heat-shrink tubing, heatsink grease, circuit board standoffs, solder, etc.

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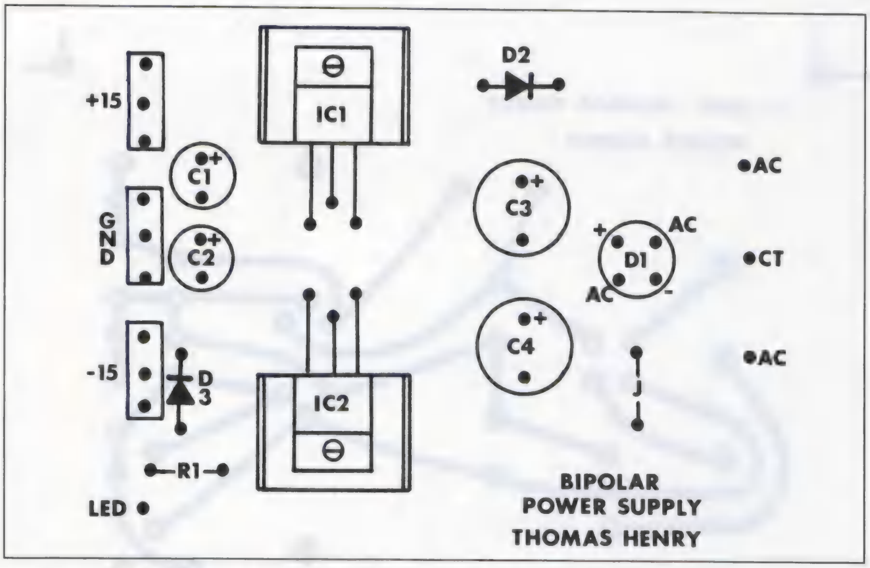

+15
GND
-15
IC1
IC2
C1
C2
C3
C4
D1
D2
D3
R1
LED
AC
CT
AC
J
BIPOLAR POWER SUPPLY THOMAS HENRY

Fig. 3 *Parts placement diagram for the component side of the board.*

secondary *of the transformer, not the high-voltage AC primary!* The center tap connects to hole CT.

This supply is good for up to 500 mA of current per side, but only if heatsinks with sufficient surface area are firmly attached to the two regulators. The circuit board has been laid out with plenty of room for the heatsinks. You can use commercial heatsinks, or make your own.

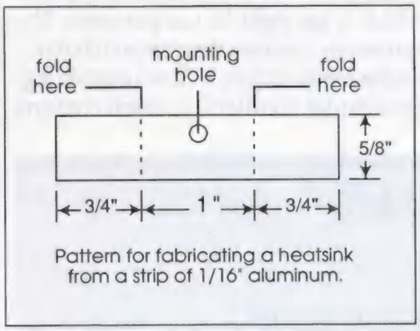

fold here
mounting hole
fold here
5/8"
3/4"
1"
3/4"
Pattern for fabricating a heatsink from a strip of 1/16" aluminum.

Fig. 4 *Pattern for fabricating a heatsink from a strip of 1/16-inch aluminum.*

Fig. 4 shows how to make a suitable heatsink from a piece of 1/16-inch aluminum stock. First cut out the required pattern from a piece of aluminum. Next drill the bolt hole, and then using a vise and hammer, fold the two tabs upward. Finally, paint the entire heatsink flat black, to aid in thermal conduction.

Fig. 5 shows how the regulator and heatsink mount to the circuit board. Be sure to liberally smear the underside of the regulators with silicon heatsink grease before affixing them in place.

Please note that positive and negative regulators have different pinouts. Before securing each regulator in place, be sure you have the right polarity and convince yourself that you are familiar with the arrangement of the pins. **Fig. 6** illustrates the pinouts of both the 7815 positive regulator and the 7915 negative regulator.

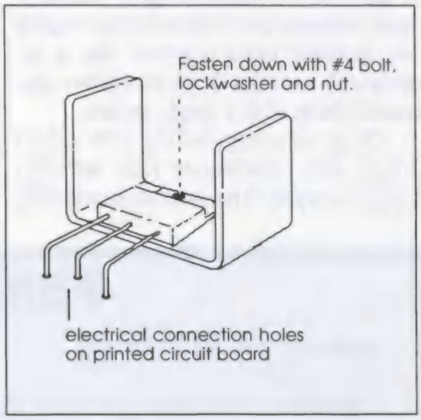

Fasten down with #4 bolt, lockwasher and nut.
electrical connection holes on printed circuit board

Fig. 5 *How to mount a voltage regulator to the circuit board.*

The rest of the circuit is easy to wire up, but here are three important safety tips:

1. *Be sure all 110V connections are completely covered.* This includes connections to the fuse, switch S1, the convenience outlet, and the transformer. I recommend that you use heat-shrinkable tubing for this purpose.

2. *Mount the circuit board using standoffs so that nothing can become trapped underneath it (and added safety comes from*

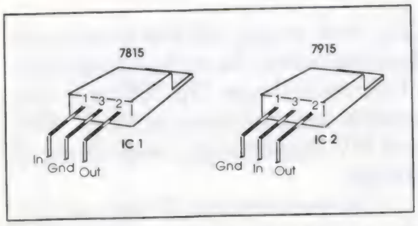


Fig. 6 *Voltage regulator pinout diagram.*

adhering electrical tape to the chassis underneath the board). Beads of solder, shards of aluminum, and other conductors can seriously damage the power supply if they come in contact with the copper traces of the circuit board.

> **All of the electronic parts used in this project are easily obtainable; these are truly "garden variety" components.**

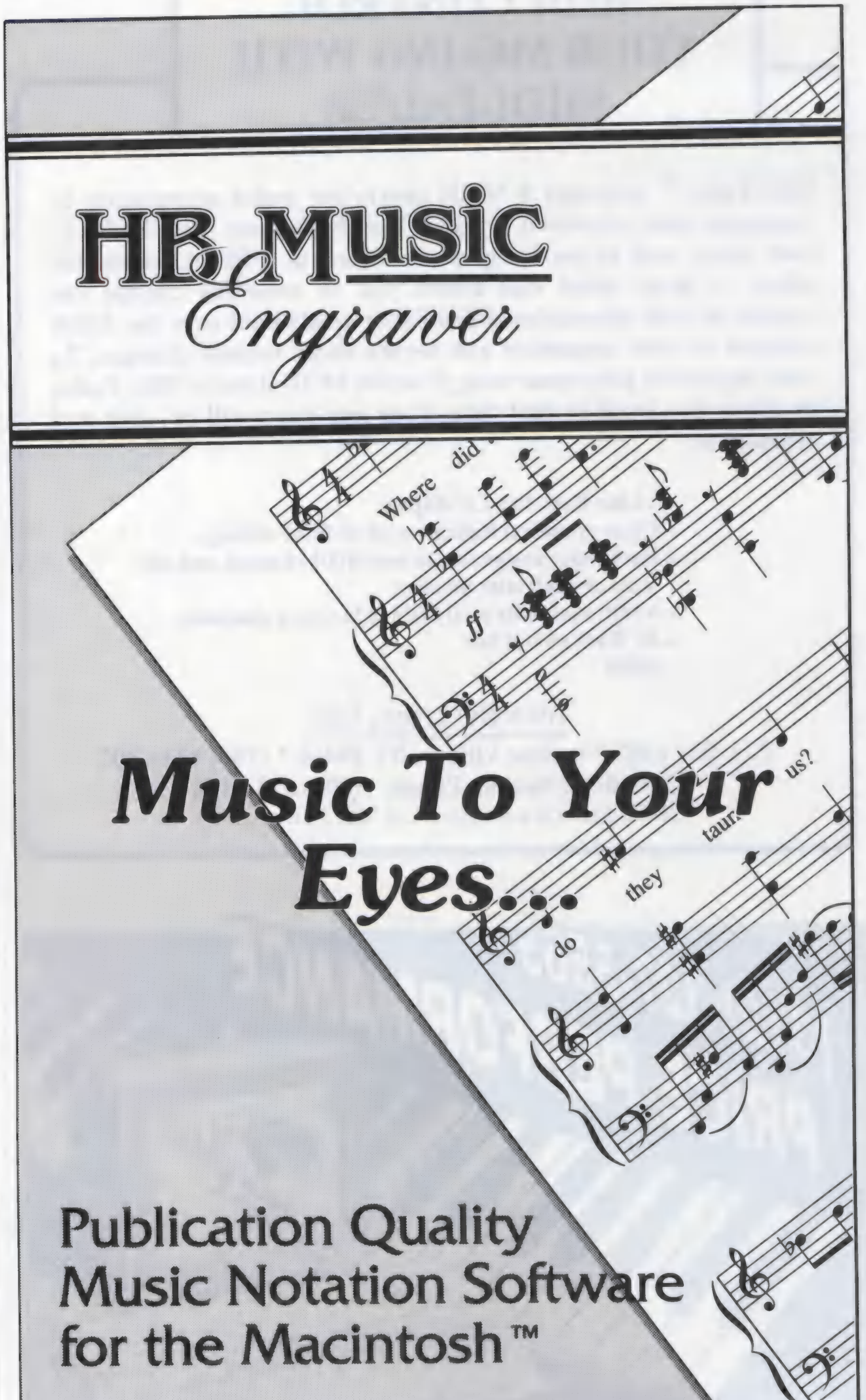
3. *The regulators dissipate quite a bit of heat during normal operation.* Be sure that the fins of the heatsinks do not contact anything which can melt or burn. Route all insulated wires away from the heatsink, unless you like the scent of melting plastic!

All of the electronic parts used in this project are easily obtainable; these are truly "garden variety" components. To make up a shopping list for the bipolar power supply, refer to the Parts List.

BIPOLAR POWER SUPPLY MODIFICATIONS

Here are two suggestions on how to customize the bipolar power supply for your own special requirements.

1. The parts values specified in the schematic set up the supply for 15V operation. You can change the output voltage easily, however, simply by substituting a different transformer and a new pair of regulators. Choose the transformer such that the peak voltage, measured across one leg and the center tap, is at least three volts and preferably about five to six volts higher than the desired output voltage



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(any more voltage will lead to excessive heat dissipation). Next, choose regulators of the desired type. The 7815 and 7915 come in standard values of 5V, 8V, 12V, and 15V, thus allowing a wide variety of voltages.

2. In the schematic, T1 was rated at 2 amps total (that's 1 amp per side). This insures that the entire circuit can provide up to 500 mA per side, with a good safety margin to boot. If you don't need as much current, you may reduce the size of transformer T1 appropriately. If you plan on drawing less than 50 mA per side, you may also eliminate the two heatsinks entirely, as long as there is reasonable air flow around the regulators. Also, for a low current version of this circuit, you may reduce the fuse to a value of 0.5A as well.

And that's that! As mentioned earlier, a good power supply is an indispensable part of most electronic music instruments. And it needs to be so reliable that you can count on it at all times, whether at practice, on stage, or in the studio. I think you'll find this design fits the bill! **EM**

—from page 13, LETTERS

problem. As for additional features, the 5532 will function as a very good preamp, as described in the modifications section. Concerning the distortion circuit, we're not actually distorting the fundamental frequency so I wasn't too concerned about the type of harmonic being generated. While visual feedback is nice, I wanted to keep the price down: for a few more dollars, though, a number of blinking LED indicators can be added."

Additions and Corrections

In the September issue of **EM**, Kirk Austin said that a limitation of the Yamaha RX5 was that individual sounds couldn't be assigned to any play button. A Yamaha representative (along with several readers) has informed us that although that appears to be the case at first glance, sounds *can* be copied to different RAM locations using the copy voice command (Job 9 in the Key Assign mode), whereupon the sound can then be assigned to the desired play button. Also, it appears that some language used in the review was ambiguous; please note that the RX5 does not *record* samples—it *plays back* sampled and FM sounds.

In the Sept. issue, "The $10 Harmonic Sweetener," page 34, third column, replace R5 with R8 so that the sentence reads "R8 should only be turned up a *little bit* . . . ."

Also in the Sept. issue, "Digitech/IVL Steel Guitar-to-MIDI Interface," the 8-pin DIN cords that connect the preamps to the main module are 20 *feet*, not 20 inches long. **EM**

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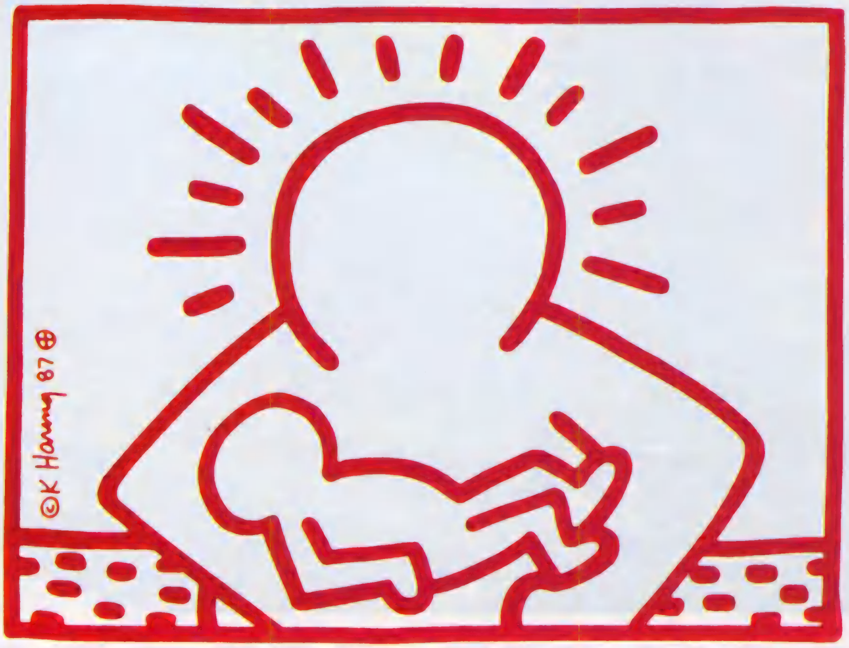

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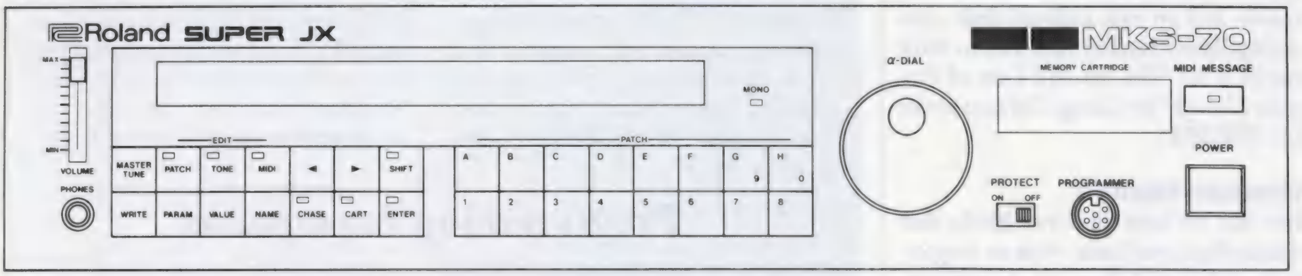
Some people think analog synthesis is obsolete, but when you can use it to make sounds like this, there's obviously a lot of life left in the technology.

Roland MKS-70



BY CRAIG ANDERTON

When Roland released the D-50, its enthusiastic reception made it the *de facto* standard-bearer of the Roland synth line. While it certainly deserves the attention it's getting, Roland is more than a one-synth company. Their 2U (two rack space units high, equivalent to 3½-inches) rack mount MKS-70 occupies a strange market niche; it's basically a high-end hybrid synthesizer (analog circuitry coupled with digital oscillators and control) but costs $2,295—considerably more than the D-50. It programs like an analog synth, although it offers an extremely clean, almost "digital" sound quality. And it uses an unusual voice architecture that can be rather confusing at first. Yet the MKS-70 is nothing if not a class act, and it merits a better fate than to have to live in the shadow of its "superstar" little (big?) brother.

Product Summary

Product: MKS-70
Type: 2U rack mount, MIDI capable, analog/digital hybrid synthesizer
Price: $2,295
Manufacturer: Roland, 7200 Dominion Circle, Los Angeles, CA 90040 ☎ 213 / 685-5141.

THE VOICE ARCHITECTURE

The key to the MKS-70's appeal is its flexible voicing structure, so let's dive right in and try to make sense of it.

The synth is comprised of two *Blocks* (A and B), each of which contains six *voices*. Each voice consists of a DCO (digitally controlled oscillator), VCF (voltage-controlled filter), VCA (voltage-controlled amplifier), and two ADSR (four-stage) envelope generators. In MIDI Poly mode, each Block responds polyphonically to one MIDI channel (duo-timbral operation); in Mono mode, *each voice* responds to its own channel (the two sets of voices in the two Blocks can be ganged together so that six pairs of voices are accessible over six channels, or treated as 12 individual voices accessible over 12 individual MIDI channels).

The MKS-70 also stores 100 *Tones* (50 in ROM and 50 user-programmable). Each Tone consists of the *parameters* (oscillator waveform, envelope generator settings, etc.; see sidebar, "Programming Parameters") that govern what the voices will sound like. Stay with me, now... each Block can be assigned one of the Tones (called Tone A when assigned to Block A, and Tone B when assigned to Block B), and the Tone parameters affect the voices in that Block.

Just in case you aren't confused yet, you can furthermore store 64 *Patches* that contain *performance parameters* (Roland calls these *Factors* for reasons I don't fully understand) that describe how the two Blocks are configured (such as the Tones assigned to the two Blocks, the balance between Tone A and Tone B, split point, pitch shift of a Tone, keyboard mode, modulation, etc.; see sidebar, "Factors"). Patches are what you actually call up on stage when you want to change sounds.

See? I said it was confusing at first.

In addition to editing this magazine, ***Craig Anderton*** *spends as much time as he can in the studio. He recently assisted the mixdown and production on* Valley in the Clouds *for Narada records, and is currently working on a new set of material for his band Transmitter.*

But as you work with the synth, it all falls into place and this approach gives us a lot of options—as we'll see in a bit.

Concerning memory, there is *internal* memory and *cartridge* memory. Either one holds 100 Tones and 64 Patches, so if you use the cartridge included with the unit (extra cartridges list for $89.95), you can have 128 Patches available for instant recall at one time. Patch numbers use the same Bank/Number scheme (A1, A2 . . . H8) that wreak havoc when you're trying to figure out what Patch corresponds to what MIDI program number, but at least you need press only one number if only one number or letter changes. For example, to go from A3 to A7 or A3 to B3 requires one keystroke. (For more information and an easy look-up chart converting Bank/Number schemes to MIDI numbers see "The Ins and Outs of Program Change" by George DaNova in the July 1987 **EM**.)

KEYBOARD MODES

Now that we have these two Blocks that contain their own Tones, what are we gonna do with them? There are six options:

A Whole: This mode assigns Tone A to both Blocks, yielding 12-voice polyphony.

B Whole: Does the same thing with Tone B.

Dual: Pushing a key plays a voice from Block A and B simultaneously, thus giving six-voice polyphony.

Split: Each Tone provides one side of the split, thus giving six voices per split and 12 voices overall. You can create an interesting three-way split by setting the lower split point higher than the split point; the keyboard will then play Tone A at one end, Tone B at the other, and both Tones A and B in the overlap.

Touch Voice Select: This allows for six-voice polyphony with velocity switching. In other words, play soft and you trigger one Tone, play hard and you trigger the other.

Crossfade: This is like Touch Voice Select, but as you play harder, one Tone fades in while the other fades out. This feature is pretty common with samplers, but it sure sounds good with synths as well.

Given the two Blocks, two Tones, and six modes, you can get sounds that are anything but "static" synth sounds. Intelligent use of the crossfade and dual modes can give some incredible effects; check out factory Patch B3 (internal), where playing softly gives you a choir, and play-

Factors (Performance Parameters)

Some of the parameters you can set include the two Tone numbers used in a Patch, Tone level balance, individual pitch shift for Tones A and B (± 2 octaves unless you exceed the range of the instrument, in which case pitch wraps around), Tone B detune, upper and lower split point, total volume, aftertouch response (can be set individually for vibrato, filtering, and/or volume), sustain (called hold), modulation depth for modulation received over MIDI, portamento on/off for each of the two Tones when portamento info is received over MIDI, bender on/off (works similarly to portamento on/off), bend range (2, 3, 4, 7, or 12 semitones), chase play level (level of "chased" sound), three chase modes (one—first Tone A plays, then B, then A, then B, etc.; two—Tone A plays followed by repeats from Tone B only; three—Tone A followed by Tone B with no more repeats). You can also set the delay time between repeats in chase mode.

Finally, we have some spiffy key assign modes. These determine how the six voices will be assigned in each Tone. Options include two polyphonic modes; unison 1 (two voices are assigned to each key in each Block—you can only play three notes at a time, but wow, what notes!); unison 2 (same as unison 1, but one Block is tuned down an octave); mono 1 (for each Block, one voice is assigned per key); and mono 2 (fondly nicknamed "Godzilla" mode; for each Block, all six voices are assigned to one key).

Programming Parameters

The MKS-70 offers a generous helping of programming parameters. These include:

Oscillators Range (four octaves); waveform (sawtooth, non-variable pulse, square, and noise); semitone tune (over ± 1 octave); fine tune for DCO 2 (for beating effects and such); LFO depth; two types of overall envelope depth (one if you're using just the envelope, the other if velocity is being used to alter the envelope depth—in this case, you can alter the sensitivity to velocity); envelope mode (chooses one of the two available envelopes and determines whether response is normal or inverted); and four sync modes—sync 1 (traditional hard sync), X mod (each oscillator frequency-modulates the other), sync 2 (hard sync and X mod), and off. I haven't seen such an embarrassment of sync riches since Korg's Mono/Poly, and they're most welcome. All of these except the sync mode and velocity envelope depth can be programmed individually for each DCO.

Mixer Adjusts the level of DCO1, DCO2, amount of envelope if envelope controls DCO2's level, dynamics range (when the envelope controlling DCO2 is being altered by dynamics), and the envelope mode for DCO2's amplitude envelope (this chooses one of the two available envelopes and determines whether response is normal or inverted).

VCF Fixed high-pass filter frequency, VCF cutoff, VCF resonance, LFO depth, VCF envelope depth, VCF tracking (called key follow), dynamics range (when the envelope controlling the VCF is being altered by dynamics), and envelope mode (chooses one of the two available envelopes and determines whether response is normal or inverted).

VCA/Chorus VCA options are VCA level, VCA mode (whether amplitude is affected by envelope 2 or a simple gate), and dynamics (response to velocity); the chorus offers two chorus options and off.

LFO Nothing unusual—waveform (sine, square, or random), LFO delay, and LFO rate. The latter two are thankfully quantized to 99 levels (much more than the 32 or 64 that many synths seem to deem adequate).

Envelopes The two envelopes have individual parameters for attack, decay, sustain, release, and key follow (where higher pitches have shorter envelope times).

ing harder mutates this into brass. Incidentally, I know factory patches take a lot of heat so it's worth noting that the ones in the MKS-70 really do show off the capabilities of the instrument very well. I found many of them not only musically useful, but instructive in programming techniques.

> **It's worth noting that the MKS-70 (factory patches) really do show off the capabilities of the instrument very well. I found many of them not only musically useful, but instructive.**

PLAYING MODES

There are three main operating modes: *Play* (which allows for limited editing over commonly changed parameters—tune, MIDI channel, mode, etc.); *Edit* (where you can really mess around with the sound); and *Write* (for loading data into memory or cartridges). One interesting option available in the Play mode is Chase, which provides a useful programmable delay effect.

WHAT'S IT LIKE TO USE?

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Roland PG-800

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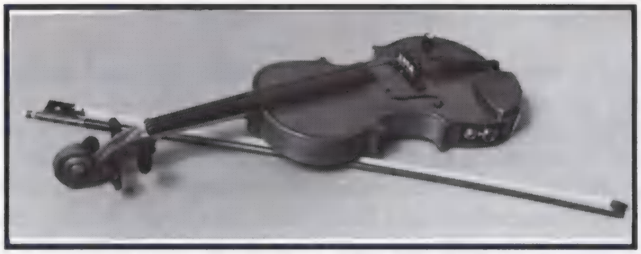

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even those of us with glasses can read onstage; when selecting Patches the display shows Patch names (up to 18 characters), the Tone assigned to each Block, and whether the Patch number shown is for the cartridge or internal memory. The second nice touch is the *alpha dial* used for editing. Those who haven't used this method of parameter-setting are in for a treat. The alpha dial is a large diameter, continuously variable knob; punch the front panel *Parameter* button, and twirl the dial to scroll through the parameters. This is a great way to scan through a Tone to see how the parameters are set and to get a sense of how the Patch is constructed. If you encounter a parameter you want to change, press the *Value* button and twirl the dial to set the value. This is a fast, efficient, painless approach to parameter-controlled synthesizers that I like a lot. If even this strikes you as too much work, you can use the PG-800 programmer ($350) and use regular dials and sliders to make adjustments, just like in the days of early analog synthesis.

Regarding sound quality, we're talking *sleek* and clean. The sound is bright but not buzzy or strident, yet the lower registers can be warm and resonantly rich if desired. The main catch is that the dual, split, touch velocity, and crossfade modes are so powerful you'll end up using this as a six-note synthesizer more often than not. Generally this isn't a problem with percussive sounds, but if you play a six-note chord with a long release and then play another six-note chord immediately thereafter, all the decays of the first chord will be cut short. On the other hand, a lot of the patches can be tweaked to give highly acceptable sounds in A Whole or B Whole modes if you need 12 voices. This is one of the clearest-sounding synths I've had the pleasure to use; even the "zipper noise" caused by stepping through quantized filter and VCA settings is virtually nonexistent.

MIDI-wise, the implementation was obviously planned to do double-duty for keyboard players and guitarists. For a guitar synthesis system, this is a good high-end expander module. It can recognize Note-on Velocity, Aftertouch, Pitch Bend, Program Change, System Exclusive messages (of course), and five "standard" controllers (1, modulation; 5, portamento time; 7, volume; 64, sustain switch; and 65, portamento switch). You can't remap controllers or anything, but I guess that's why devices like the Axxess Mapper exist.

Concerning the manual. . .well, the operational information is all in there, but it takes study, concentration, and practice to extract it. Fortunately, you can take a couple of laminated plastic "cheat sheets" supplied with the unit on gigs in case you can't remember everything (and there is a lot to remember). There is virtually zero printed information on applications, but actually, scanning through how the Patches are programmed will tell you more about how to make cool sounds than dozens of pages could. This is another reason why I think it's important for companies to put as much effort as they can into programming factory sounds; we're not just talking about a sales tool here, but an educational one as well.

MIDI-wise, the implementation was obviously planned to do double-duty for keyboard players and guitarists. For a guitar synthesis system, this is a good high-end expander module.

Quite frankly, I was expecting "another analog synth" but this one surprised me. It's clean, it's versatile, it has great sound quality, and it works well with my Roland GM-70 guitar-to-MIDI controller. It's also not cheap, but then again, it doesn't look, feel, or sound cheap either. If you're looking for an analog-style synth to round out your collection of sound generators, the MKS-70 will get you there in style. EM

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ALESIS
STUDIO ELECTRONICS

The rising prominence of MIDI is changing the shape of the recording studio in many ways. MIDI even places new demands on mixing boards, and here's one candidate that seems eager to take on the job.

The Seck 1882 Mixer

BY TIM TULLY

Like a lot of us, I started building my home studio when the heart and soul of such an enterprise was the multi-track tape deck. As I added new equipment to the studio, it was always with the process of multi-tracking in mind. Then, along came the MIDI monster.

It didn't take a Nostradamus to see that once you had your synths and drum machines talking to computers, there would be a whole lot of new games to play. However, it does take a few dozen geniuses to put all the items required to play those games through design and production processes, and the naturally occurring shortage of geniuses in the world insures that not all the juiciest gadgets inevitably get into the stores. So while we've seen everything from our rhythm tracks to our ironing boards automated under the auspices of MIDI, there is one implementation—at least within the rather limited capabilities of *my* budget—that hasn't flooded the NAMM shows and music stores. This elusive butterfly is the *mixing board* designed specifically for the (usually small) home-type studio glued together by MIDI.

Product Summary

Product: 18 × 16 × 2 mixing board
Price: $4,800
Distributor: Connectronics Corporation, 652 Glenbrook Rd., Stamford, CT 06906 ☎ 203 / 324-2889.

WHAT IT IS

What has happened is that some of the hippest features of MIDI recording have moved the focus of the studio away from the multi-track tape recorder and towards the mixing board. (This is not to say multi-tracks are or will soon be obsolete, by any means. These machines still have, and will continue to have, immense importance, if for no other reason than that real-world budgets *cannot* MIDIfy such phenomena as singers and certain acoustic instruments—including the ubiquitous guitar.) But if a given studio is *always* using *only* MIDI sound generators (synths, samplers and drumboxes), or if it uses mostly MIDI, but still caters to the occasional voice-over, singer or bassoon player, the *advantages* of major MIDI implementation put new demands on the mixer's design and performance, and require certain features and functions.

I've been looking for the board that would fill my specialized MIDI needs (while not emptying my bank account) for a while now, and the Seck 1882 seems to fit the profile. The 1882, retailing at $4,800, is (nominally) an 18 × 16 × 2 board. I say "nominally," because this console's design incorporates unusual input and output flexibility that meets my MIDI-generated needs very well. It has a sound quality that is quite reasonable and, while it has an overabundance of mic inputs that my MIDIed setup will *never* use, and for which I am loath to shell out, so does everybody else's. So all I can do is complain.

But let's look at things in perspective. The first, most obvious of the demands a MIDI studio puts on its console is for *inputs*, and lots of 'em. There are a number of reasons for this. Any sophisticated mix, first of all, will use *all* the outputs available on a drum machine. This is necessary for the "sculpting" of not just the overall sound as it comes from the drum machine's mono or stereo output, but of every instrument. For this you need: at least decent equalization, the ability to pan the drums across the full stereo field, and features for applying the right kind and amount of signal processing to individual drums. You also need visible control over the level of each instrument *at the board,* without having to go back to the drum box. This kind of control is important, but it eats up from six to 12 inputs.

Synths and samplers add more complications. One of the ways MIDI expands the scope of a studio is through multitimbral instruments like the Yamaha TX802 or the Korg DSM-1. Such machines pump out from six to 16 different timbres each capable of playing a melody different from the rest through as many audio outs. But now we're using anywhere from 12 to 28 inputs. Furthermore, if you *do* integrate a multi-track deck into your otherwise-MIDIed operation, at mixdown your sources will be not only MIDI instruments (being played live by your sequencer), but will also include whatever tracks you've already recorded on the multitrack, running in sync with the sequencer. Even more inputs are needed to get the outputs of your outboard effects *back into* the mix, but we'll address that after we get the signal *to* the effects first. But you get the picture: we need inputs.

The Seck 1882 console has 18 standard input channels, each assignable to the usual mic, line, or tape inputs. Beyond this rather customary setup, however, each channel has a "monitor" section with level, pan, and two effects sends, and each of these channel monitors can take input from a source *separate* from the rest of the channel and route it to the mix (with a little bit of clever patching that uses two of the regular inputs). This gives you 16 additional inputs. These inputs have less sophisticated fader capabilities and no equalization, but a decent sequencer will give you level changes itself, via MIDI controller 7, and careful programming of your synth patches can obviate the need for extensive EQ. Alternately, at least *some* of your multi-track performances should be mixable without EQ if you don't rely on a "fix it in the mix" recording technique in the first place.

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It didn't take a Nostradamus to see that once you had your synths and drum machines talking to computers, there would be a whole lot of new games to play.

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If you really want to push it, the eight *Group Faders* on the Seck each have insert points—intended as combined aux send and receive buses—that with custom-wired cables that even I can make, can act as inputs too.

There is a three-band EQ section on each input: a high and low shelving, and a sweepable midrange with boost and cut (there's no bandwidth control, though). I'm an EQ glutton—always looking for more—but I found this arrangement pretty satisfying. We measured the sweep control as typically going from 317 Hz to

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6.7 kHz, and I was able to zero in on the aural "sweet spot" of every instrument my drum machine has. The top and bottom sounded good and measured well, with the exception of a tiny bit of loss at the very top of the top end. Basically, this board offers good EQ and upwards of 38 inputs, and I'm not sure there aren't more lurking in some obscure configuration I've missed. This is real good stuff for the MIDI-minded.

OUTPUTS

Outputs are the second-most-necessary feature for a MIDI board: not just tape outs, but the "aux" outs going to signal processors such as reverb and delay. There are a couple of reasons for this. First, when you record into a sequencer instead of a multi-track, you don't process the signal while recording—so you need a *lot* of signal processors during mixdown. The upside is that signal processors are getting pretty inexpensive, *and* controllable by MIDI. (This means your sequencer can automatically and immediately switch a processor among different settings and synths, to do many jobs almost at once.) So since you will be recording "live" (i.e. your sequencer is playing your synths) to a stereo mix, with perhaps some synchronized multi-track stuff thrown in as well, you need ideally to be able to send each channel to every signal processor you own.

To this end, the Seck board can give you up to *six* aux out/foldback circuits per channel (three if you use the monitor section as channel input). That's as many as I've seen on even significantly more costly consoles.

To get the output of all these effects units back into the mix, there must of course be *returns*. Much of the time we're forced to use up some precious input channels for this, but the 1882 has four *aux returns*, each with two-band EQ, solo button, level and pan pots, and the same five-button routing as the input channels. Two other returns are mixed with the monitor signal.

We lab-tested the 1882, and the measured specs closely matched the machine's stated specs. The headroom was around 20 dB; the equalizer—whose silk screen markings on the top panel were quite accurate, with the exception of two rogue channels that showed a 15% variation at 1 kHz—provided *at least* the quoted 15 dB cut and boost, excepting

Hill Multimix

Although mixers designed for electronic music studios are few and far between, some "conventional" mixers seem more suited to the task than others. Hill's "Multimix" is one such mixer.

In normal use, this is a 16-input mixer with simultaneously available stereo and mono outputs (the latter is useful when checking for phase problems and AM radio compatibility). However, channels 13 through 16 are four special "subgroup" channels that can carry the signals from four corresponding subgroups *in addition to* the standard channel inputs. (Since both will be controlled by the same individual channel fader, though, you would want to choose signals that require level changes of the same degree and at the same time—like different elements of a drum kit.)

Each channel can switch between a line input and transformerless balanced mic input (with 48 Volt phantom power, if desired). A gain control matches levels, while a pad switch further reduces mic signal levels if necessary. Of course most MIDI studios won't record 16 mics at the same time, but this mixer is, after all, designed to do more than just MIDI studio functions. Inputs 1 through 4 have RIAA (Recording Industry Association of America) equalized inputs for plugging in a turntable; that feature doesn't do too much for me, but rap artists and disco DJs will probably be glad they can use this mixer too.

Post-fader direct outputs are available for all channels (just the thing for tapping off a signal that can be processed and then returned to another input). In addition, an output switch for the four subgroup channels selects between +4 dBm or -10 dBV signal levels at the direct output. There are also two aux sends with one aux return. One send is set up as pre-fader/insert jacks/EQ, the other as post-fader/insert/EQ. However, these can be modified easily so that either one can be pre- or post-fader/insert/EQ. How easily? Well, the Multimix includes full schematics that clearly indicate those points where mods (such as where to add channel insert points

MULTIMIX
P.S.1
hill

the midrange (we measured a cut of 13.6 dB, which represents less than a 10% deviation). The frequency response was very close to the stated +0/-1 dB. The noise figures were the usual problem. Although our figures were close to spec again, we "A/B-ed" the Seck against a Hill Audio Multimix whose noise specs looked close to the Seck's and the Hill seemed audibly quieter (see sidebar). This is not surprising since the Seck mixer has so many fader/gain/input/etc. configurations at which to measure noise, so it's always difficult to draw any real conclusions without a direct, side-by-side aural comparison. At any rate, the 1882 showed a respectable, but not stunning, lack of noise, certainly adequate for sound reinforcement, broadcast mixes, and the majority of small studio applications.

NO TEAK, NO VINYL

This no-frills boast, taken directly from the Seck product literature by a reviewer who knows a good one-liner when he reads one, sums up the construction of this unit. The 1882 is an amazingly compact board. It measures 39¼ inches wide, 18 ¼ inches deep and an amazingly small 1 ⅞ inches high. It is eminently portable, especially with the solid metal handle that comes included. All its inputs and outputs are at the top rear of the front panel, allowing the small studio owner to stick the console flush against a wall and still get at the cords. This arrangement makes all the connections time-savingly visible and accessible, and cuts down the need for patchbay connections quite a bit. The circuit boards lie in the same plane as the top panel, directly below it. This means all the plugs, pots, and faders are mounted directly to the component side of the circuit board so there are no wire connections. This is bound to create greater reliability and ease of repair. These works slide into a simple, solid two-piece extruded aluminum frame and are sealed with two aluminum end caps. All this gives the board a workmanlike feel and keeps costs down.

Other, less MIDI-specific features worth mention include: 16 tape outs coming from eight group faders, each with a send/receive insert point for individual, one-plug signal processing; slating and talkback (with a built-in mic); and a left/right LED meter switchable between peak/hold and average metering. There are two headphone jacks and 18 mic inputs with switchable phantom power from the external power supply. Solo buttons can be found on just about every input.

CONCLUSIONS

The noise levels on the 1882 could be a problem for very delicate music or high-quality digital stuff, but would be insignificant in a lot of applications—let your ears be the judge. On the other hand, the design of this board knocks me right out. I get a very comfortable feeling of accessibility and control over all my signal routings, and the unit seems quite compatible with a MIDI sequencer/synthesizer/drum machine studio. When I consider the lack of attention most companies seem to be paying to the needs of the working MIDI studio, the 1882 gets high grades.

***Tim Tully** lives in the hope of finding the perfect waveform. When he finds it, he will process it in every possible way, and then gloat with the satisfaction that it still doesn't sound like a real sax.*

and how to make the aux sends pre- or post-fader) can be added. I always give high marks for this kind of documentation, as it lets those who really know mixers get the most out of the unit, and even repair it in a pinch if necessary.

The EQ deserves special mention. My philosophy is that console EQ should be used for broad-bandwidth, general tone shaping; why include costly, space-hungry three-band parametric EQ when you can use external units and patch them in as needed? Hill seems to subscribe to the same philosophy—the three-band, fixed frequency (100 Hz, 1 kHz, and 10 kHz) equalizers use essentially passive circuitry and are extremely clean and quiet. They also have an in/out switch to compare equalized and non-equalized settings.

Other controls of note include PFL level (the "pre-fader listen" signal used for a mono headphone cue mix), and Pan and Routing. The latter two controls work together, with the routing switch selecting subgroups 1 and 2, subgroups 3 and 4, or stereo master (left/right), and Pan crossfading between the two options in each routing selection. As you might expect, there is a peak LED indicator for each channel, and dual 12-segment LED output meters.

Hill manages to cover a lot of bases with this mixer. Being able to use four of the inputs as subgroups, coupled with the extremely quiet performance and unobtrusive EQ, make this a good choice for small home studios and MIDI setups. It's also a useful "expansion mixer" to mix down the outputs from, say, a multi-output drum machine into a main mixing console. Yet the Multimix would also make a fine keyboard or utility mixer for the musician on the road, thanks to its compact, all-metal, rack mount packaging. For this application, having the jacks on the back is an advantage; with the typical ever-changing MIDI studio configuration, though, the rear-panel jack placement makes patching more difficult (I'd certainly hook up a patchbay for any serious studio use). Hill also offers a couple of accessories—a 2U rack with insert jacks for each channel, and another 2U box that adds an additional two aux sends per channel (six of these can be ganged for up to 12 additional aux sends per channel).

If you want a fancy designer mixer with lots of bells and whistles, this is probably not the model for you. But if small size, sturdiness, low noise, and clean sound are important, for $2,299 this unassuming package is an extremely strong contender.

—Craig Anderton

(Hill Audio Inc., 5002B North Royal Atlanta Drive., Tucker, GA 30084 ☎ 404/934-1851.)

Every sequencer has its own unique set of advantages and disadvantages. Opcode's offering has a reputation as hard-working, reliable software with some unique twists... and Geary investigates why.

Opcode's MIDIMAC Sequencer 2.5 for the Mac

BY GEARY YELTON

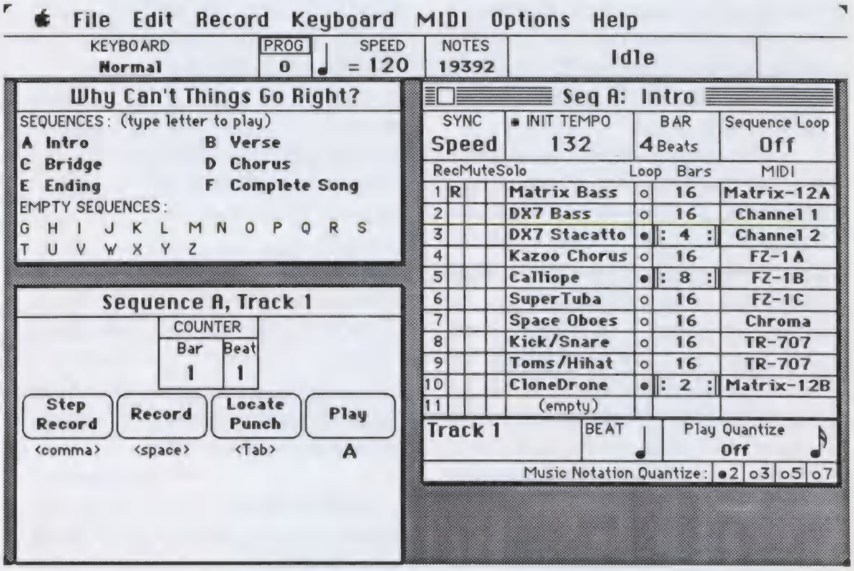
When Opcode's MIDIMAC Sequencer came out in the summer of 1985, it changed my life forever. I began to compose music I could never have performed with just my own two hands. My old 4-track tape deck grew cold from neglect as my synthesizer setup began to sprout real time multitimbral capabilities. Two years later, I'm pleased to report that the first fully functional Macintosh sequencer is still one of the best.

Geary Yelton is a synthesist, writer, publisher, and MIDI consultant from Atlanta, Georgia. He is the author of The Rock Synthesizer Manual, *published by Rock Technologies.*

FEATURES

You want features? I'll give you features: up to 26 sequences per song file with a total recording capacity of up to 24,000 notes on a Macintosh 512K; 16 tracks per sequence; the ability to play as many as 16 independent sequences and up to 32 tracks simultaneously; a range of tempi from 1 to 500 beats per minute; recorded tempo changes; internal or external clock sync; selectable MIDI adapter clock speed; punch-in and punch-out editing; MIDI message filtering; triggering and transposing sequences from your synth keyboard; track and sequence looping; several kinds of file conversion; and excellent adherence to the Macintosh user interface. If you're a synthesist with a Mac, this sequencer demands a close look.

The Opcode approach to sequencing lets you record a sequence for each letter of the alphabet, and these individual sequences can be chained together to form complete songs. All control functions are governed by pointing and clicking the mouse, but the most frequently used com-



KEYBOARD Normal
PROG 0
SPEED ♩ = 120
NOTES 19392
Idle

Why Can't Things Go Right?

SEQUENCES: (type letter to play)
A Intro
B Verse
C Bridge
D Chorus
E Ending
F Complete Song
EMPTY SEQUENCES:
G H I J K L M N O P Q R S
T U V W X Y Z

Sequence A, Track 1

COUNTER Bar 1 Beat 1

<comma> <space> <Tab> A

Seq A: Intro

SYNC Speed
● INIT TEMPO 132
BAR 4 Beats
Sequence Loop Off

	Rec	Mute	Solo		Loop	Bars	MIDI
1	R			Matrix Bass	○	16	Matrix-12A
2				DX7 Bass	○	16	Channel 1
3				DX7 Stacatto	●	: 4 :	Channel 2
4				Kazoo Chorus	○	16	FZ-1A
5				Calliope	●	: 8 :	FZ-1B
6				SuperTuba	○	16	FZ-1C
7				Space Oboes	○	16	Chroma
8				Kick/Snare	○	16	TR-707
9				Toms/Hihat	○	16	TR-707
10				CloneDrone	●	: 2 :	Matrix-12B
11				(empty)			

Track 1
BEAT ♩
Play Quantize Off
Music Notation Quantize: ●2 ○3 ○5 ○7

Fig. 1 *The three main Sequencer 2.5 windows.*

Product Summary

Product: Opcode Sequencer 2.5
Type: MIDI sequencer software
Functions: MIDI recorder, real time sequence modulation, file conversion
Sequence architecture: 26 sequences per file, 16 tracks per sequence
Hardware requirements: Apple Macintosh computer, MIDI interface, second drive recommended
Retail price: $250
Manufacturer: Opcode Systems, 444 Ramona, Palo Alto, CA 94301 ☎ 415 / 321-8977

mands have Mac keyboard equivalents. Pressing letter key A plays sequence A. To stop playback, hit the return key. To record, select a track with the mouse and press the space bar. For basic operations (like starting and stopping record and playback), using the Mac keyboard is a lot more convenient than positioning the mouse. Editing is most often done either by cut and paste routines, by changing the information in *fields* (particular types of data; see below), or by punching in new parts.

THE FIRST BLUSH

When you first open the application, three windows appear (see **Fig. 1**). The *file window* shows you all the sequences in the current file. The *sequence window* displays the tracks in the currently selected sequence. Each track has four *fields* you can toggle to enable/disable record, mute, solo, and looping. A fifth field shows the number of bars in each track, and a sixth shows its MIDI channel assignment. Sequence fields indicate initial tempo, beats per bar, sequence looping, auto-correction (quantization), and other essential information. All these parameters are variable. A third window shows a bar and beat counter, as well as buttons for play, real time record, step record, and editing. When editing a track, the edit window changes to a more complex form so you can punch in and edit any part of a track down to 1/92nd of a beat.

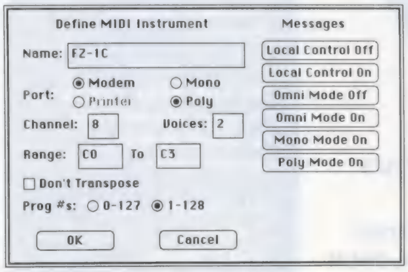
As you would expect, the MIDIMAC Sequencer records all MIDI events, not just Note Ons and Offs. To conserve memory, it lets you filter out selected events either while recording or afterwards, selectively, from a track or part of a track. Unlike some other Macintosh sequencers, tempo changes are recorded, but only if requested.

The tempo of a sequence is normally controlled by an internal master clock, but can also come from a MIDI drum machine, another sequencer, or any device that sends MIDI clock signals. I use Roland's SBX-80 to sync to tape with no problem. MIDIMAC also supports Song Pointer messages, so it can "chase" a recorded sequence on tape if it receives the appropriate Song Pointer data.

RECORDING

When you start real time recording, a metronome begins ticking and the message "Ready to Record" appears. You can now program the initial tempo or a Program Change number for your synth before you play, since recording only starts when you hit a note. (If you want to begin with a rest, hit the space bar a second time.) A counter keeps track of how many notes are left in memory. When you finish recording, you can stop or have the track loop. To record additional tracks, follow the same process, assigning MIDI channels as necessary. If you have an obliging interface or two, you can record from both ports at the same time.

All 16 MIDI channels are supported, as well as a "Multi" selection that merges a multiple-channel sequence down to a single track and retains all the channel information so the merged track can be unmerged with all its tracks intact. You can even record a 16-track sequence from *another sequencer*, then unmerge it so that all 16 tracks appear in the sequence window, each with its original MIDI channel. A MIDI menu lets you rename the channels, send mode messages, and limit each channel's range and number of voices (see **Fig. 2**). A neat feature lets you type in an instrument's name, rather than a channel number, to cut down on stuff to remember.


Define MIDI Instrument

Name: FZ-1C

Port: ● Modem ○ Printer

○ Mono ● Poly

Channel: 8

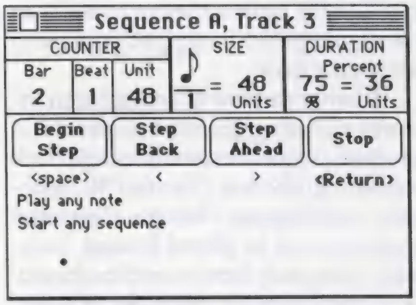
Voices: 2

Range: C0 To C3

☐ Don't Transpose

Prog #s: ○ 0-127 ● 1-128

Fig. 2 *MIDI instrument definition window.*


Sequence A, Track 3

COUNTER: Bar 2, Beat 1, Unit 48

SIZE: = 48 Units

DURATION: Percent 75 = 36 Units

Play any note

Start any sequence

Fig. 3 *Edit window in step time mode.*

For step-time recording (during which you can record MIDI velocity values), a counter lets you begin on any beat or fraction of a beat (see **Fig. 3**). You set the duration by picking a value ranging from a dotted whole note to a 64th note, including triplets. If you're composing outside the strict confines of duple and triple time, you can divide each beat by any number you require for tuplets. You can change the step size and duration at any point, and step back or forward to correct mistakes. One of the best features of this program is that you can put step-time

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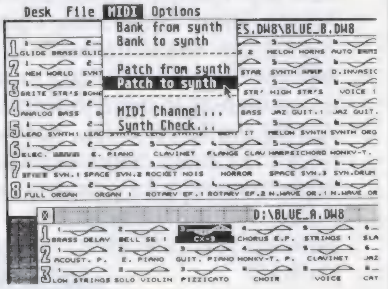


tracks in the same sequence as real time tracks, and punch in stepped portions to a real time track.

Another method of composition involves recording *generated* sequences. A generated sequence records a single track containing only Note Ons and Offs, velocities, and Program Changes. Generated sequences can be played forward, backward, alternately forward and backward, or in a random order, rather like an arpeggiator. Notes and chords are automatically quantized, or they can be played back so that each has equal duration.

When you're composing with the MIDIMAC Sequencer, you can construct large sequences from smaller "subsequences." To do this, open a new sequence and enter the letters of other sequences in the order you want them to be played. All the subsequences can be recorded on a single track, or on different tracks, triggering different sequences, and can keep each sequence's channel information with the "Multi" feature of the new track's MIDI channel field.

With the *Capture* command, you can record all the MIDI information from subsequences. An advantage of capturing is that you can edit the subsequences without affecting the original sequence, and vice versa.

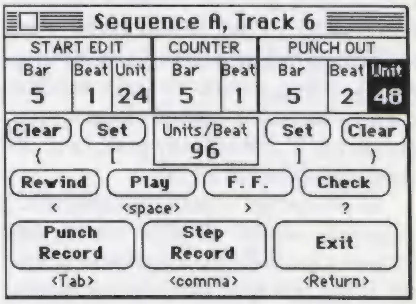
PLAYBACK

Playback is as easy as recording—to play sequence B, hit B; to stop, press Return, etc. You can change tempi and programs "live" during playback, but if a recorded tempo or Program Change is encountered, it takes precedence. Quantization (auto-correction) offers many degrees of resolution, from a dotted whole note to a 64th note's duration. You can either quantize only Note On messages—so they all occur at the beginning of the beat division—or both Note On and Note Off messages—so notes begin *and end* on the specified beat division. Even tuplets can be quantized. Notes are only quantized on playback, but you can circumvent that limitation. A quantized sequence can be "captured" or recorded into another sequence with its auto-correction intact. The MIDIMAC Sequencer's keyboard menu gives the user considerable control over playback. Your MIDI keyboard can trigger and transpose sequences in real time. In some modes, if you press more than one key, a simultaneous sequence is triggered for each key. The possibilities for experimentation are all there: check out the crazy things that happen when a sequence transposes itself; try splitting your MIDI keyboard so that part of it is used for sequence control and the rest plays normally. You can also play one MIDI channel with half your keys and another channel with the other half, even if your keyboard doesn't normally split.

Several sequences can play at the same time by invoking the *Players* command: you enter a player number and sequence letter and each sequence plays through to its completion, even when additional sequences are started. Players is most useful for staggering sequences. It's too bad you can't start multiple sequences simultaneously with Players, but there are other means to accomplish that trick.

EDITING

The edit menu lets you cut, copy, paste, clear, merge, name, and transpose sequences and individual tracks (no surprises here). At present, there's no straightforward way to cut and paste selected portions of a track, but a comprehensive graphic editing interface is planned for future releases. Use the editor window to replace or remove portions of a track and to change or filter MIDI data. When editing a track, the editor window changes to resemble the buttons of a tape transport with a beat counter at the top (**Fig. 4**). You indicate the edit points by typing in the numbers of where you want the new part to begin and end. You can punch in on the fly, or just press tab and start playing the new part. The sequence will start and stop recording automatically at the predetermined Start Edit and Punch Out


Sequence A, Track 6

START EDIT			COUNTER		PUNCH OUT		
Bar	Beat	Unit	Bar	Beat	Bar	Beat	Unit
5	1	24	5	1	5	2	48

Units/Beat 96

Fig. 4 *Edit window ready to edit sequences and individual tracks.*

Sync-Link: L.D. Systems

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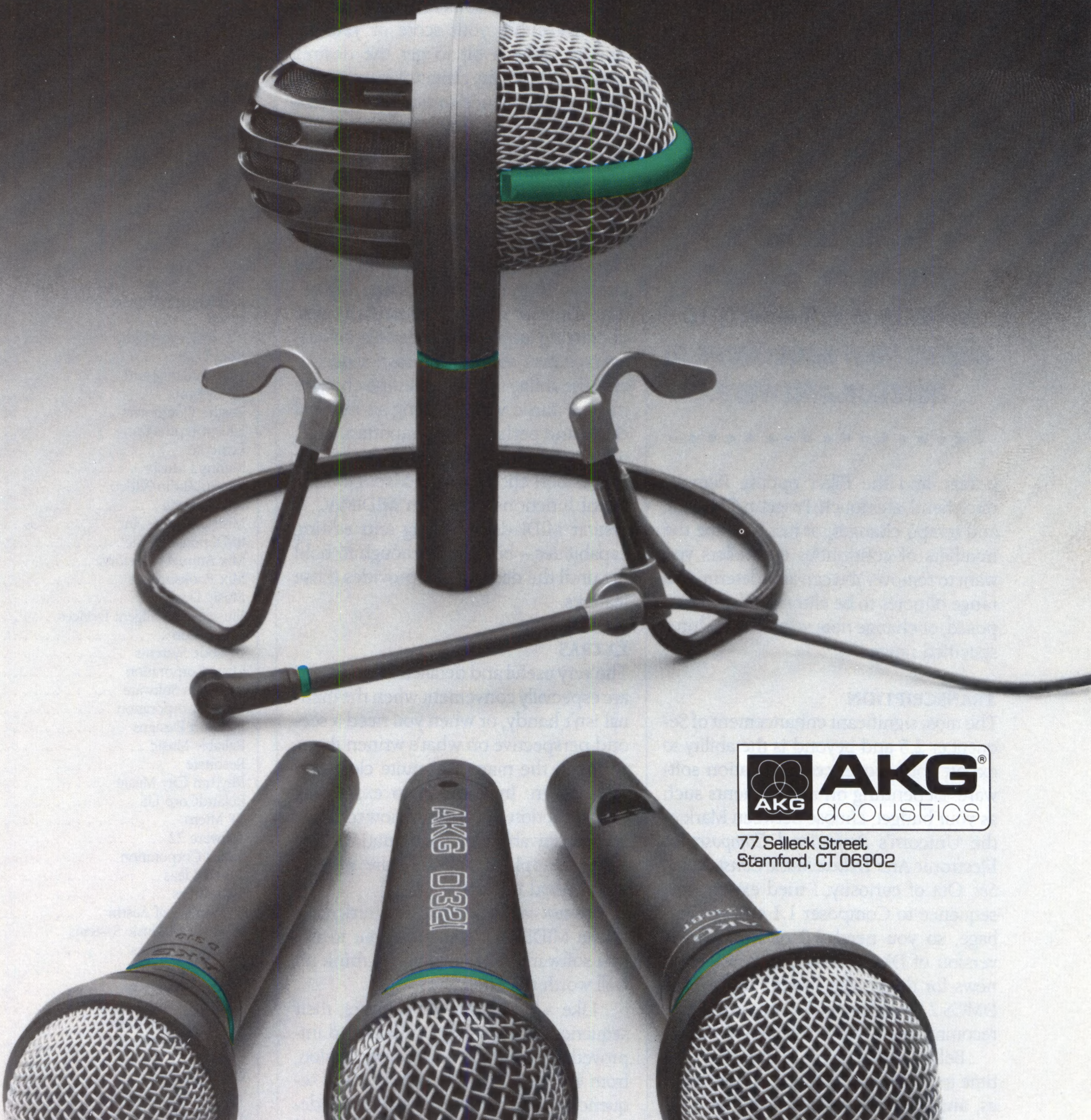

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points. You can rewind the sequence to any point or listen to only the section between the start and stop points. If you don't like the changes you've made, the Undo command restores the track to its previous form.

You can filter out certain MIDI events —from entire tracks to selected portions—by using the Start Edit and Punch Out points, and the Filter option. Remove pitch bend, aftertouch, Program Changes, and tempo changes, or just indicate the numbers of continuous controllers you want to remove. You can also determine a range of notes to be eliminated or transposed, or change note velocities within a specified range.

The most significant enhancement of Sequencer 2.5 and beyond is the ability to export your sequences to notation software.

TRANSCRIPTION

The most significant enhancement of Sequencer 2.5 and beyond is the ability to export your sequences to notation software. Depending on requirements such as your budget, choose between Mark of the Unicorn's *Professional Composer* or Electronic Arts' *Deluxe Music Construction Set*. Out of curiosity, I tried exporting a sequence to Composer 1.1 and got garbage, so you need 2.0 or later. Either version of DMCS works, which is good news for those who haven't updated to DMCS 2.0 (which, by the way, is a highly recommended piece of MIDI software).

Before transcribing a sequence, it's time to capture all its loops, subsequences, and generated sequences into a recorded sequence to create a sequence of actual MIDI events, rather than commands that only point to sequencer-generated changes. Once transcribed, each MIDI channel has its own staff, and like other such file conversions, all tracks must be quantized. A dialog box lets you indicate the key signature before exporting.

Sequences exported from the MIDIMAC Sequencer are transcribed at least as accurately as sequences exported from anyone else's sequencer. That is, sometimes sequences are properly notated on the first try, and sometimes you have to massage either your score or your sequence quite a bit to get the desired results. Despite the claims of many manufacturers, sequence-to-notation conversion is still an imperfect process. Scores written in Professional Composer and DMCS, though, can be imported into sequences with excellent results.

CONCLUSIONS

Opcode's Sequencer has so many useful features: triggering and transposing sequences from a MIDI keyboard; the ease of creating loops (another stand-out advantage over some Macintosh sequencers), the ability to execute tempo changes in your music without using an external clock, and perhaps most important of all, reliable operation. This program gets my vote as best choice for the Mac. The only set of functions I miss on MIDIMAC is greater MIDI data viewing and editing capabilities—but there's enough to hold me until the next update provides those features.

EXTRAS

The very useful and detailed help screens are especially convenient when the manual isn't handy, or when you need a second perspective on what's written there, although the manual is quite clear and well-written. In addition to explaining every function, it describes how to set up any conceivable Mac configuration. (You have to applaud any software manual with a good index.)

It's not easy to learn all the intricacies of the MIDIMAC Sequencer, but to use this software most creatively, I think it's well worth the effort.

Like a lot of Opcode software, their sequencer is frequently updated and improved. I've used just about every version, from 1.0 to 2.0 to 2.53. While some sequencers either don't get revised or develop new bugs, Opcode's gets better and more powerful with every revision. It's great to watch such good software evolve so quickly. I can't wait to see Sequencer 3.0.

Advertiser Index

Advertiser	Page
Adams-Smith	34
Akai/I.M.C.	9
AKG Acoustics	113
Alesis	57, 105
Altech Systems	47
Aphex Systems Ltd.	75
Applied Research & Technology (ART)	4
Sam Ash Music	45
Beaverton Digital Systems	81
Casio	49
Club Midi	45
CompuSound	31
Computer Music Supply (CMS)	56
Dr. T's Music Software	36, 37
Drumware	35
EarStuff	90
Electro-Voice	60
E-mu Systems, Inc.	17
Ensoniq	44, 73
Fostex Corporation	65
Future Music	88
Guitar Shack	98
H.B. Imaging, Inc.	97
Hitech Innovations, Inc.	99
Intelligent Music	20
Iota Systems, Inc.	98
JBL Professional	116
Julian Music Systems	23
Kawai	52
The Keyboard Shop	86
Korg USA	2, 3
Lake Butler Sound	23
LD Systems	112
Leigh's Computers	81
Leister Productions	87
Lexicon	10, 11
Manny's Music	62
Martin Audio/Video	7
Micro Music	28
Midi Concepts, Inc.	27
MIDImouse Music	30
Mix Annual Directory	79
Mix Bookshelf	89, 91
Music Design	92
Musically Intelligent Devices	25
Musication	87
Opcode Systems	33
Otari Corporation	104
Paradigm Software	88
Passac Corporation	74
Passport Designs	39, 85
Reliable Music	47
Resonate	62
Rhythm City Music	92
RolandCorp US	115
RP Micro	55
Software 22	35
Sonus Corporation	43
Sound Ideas	107
Soundtracs	18
Soundware of Austin	90
Southworth Music Systems	41
Special Olympics	100
Sunn	12
Synergy Resources	111
TDK	66, 67
Thoroughbred Music	77
Twelve Tone Systems	54
Valhala	21
Valley Designs	103
Voyetra Technologies	71
Wise Music	54
World Records	78
Yamaha International	15, 58, 59, 68
Zero One Research	13
Zeta Music Systems	103

EXPERIENCE M.E.S.A.: THE POWER OF INTEGRATED MUSIC SOFTWARE

Roland DXY-980
Roland

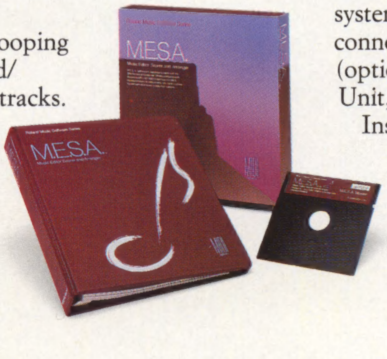
Finally, one single program gives musicians the power to control every aspect of their MIDI environment to create, arrange and produce masterful music compositions. That program is M.E.S.A. (Music Editor Scorer Arranger) from Roland. Integration is the key to M.E.S.A.'s strength as it allows you to move swiftly between its three operating modes (Song, Score and Print) to record, edit and print professional music scores without ever having to change disks or re-boot new modules — operations that could slow down your creativity.

By any standards, M.E.S.A. is a breakthrough, for not only does it provide unparalleled power, its mouse-based point-and-click user interface assures that its sophisticated operation isn't complicated. Music can be entered via a MIDI keyboard, the mouse or the PC keyboard to allow even non-keyboard players to express themselves beautifully.

M.E.S.A.'s Song Mode contains advanced sequencing functions to record and play back MIDI performances including: 50,000 note capacity, eight tracks, programmable tempo changes, timing offsets, looping function, text function and editing (Delete/Add/Merge/Move) of notes, beats, bars, phrases, or tracks.

The Song Mode screen graphically displays the structure of a composition allowing easy cut-and-paste editing and arranging.

The Score Mode transfers and displays the recorded MIDI performances in standard musical notation on the screen, automatically placing notes, rests and beams. In Score Mode, complete compositions can be created and individual notes and MIDI events can be inserted, deleted and modified. Text, phrase marks, triplet brackets, clefs and other musical symbols can be inserted into the score.



The Print Mode screen uses high-resolution graphics to display a page of up to eight staves of music exactly as it will appear when printed. Score layout is user-definable and can consist of up to 16 staves per page. Individual measures can be cut-and-pasted into any order and printed on an IBM compatible dot matrix printer or Laser printer. Spectacular, engraved-quality manuscripts can be created by using a compatible plotter such as Roland's DXY-880, DXY-990 or DPX-2000.

Hardware requirements: IBM PC, XT, AT or full compatible with two floppy disk drives or hard disk (recommended), 512K min. RAM (640K recommended), IBM or compatible EGA, CGA, or Hercules monochrome display system, parallel printer port (25 pin D-connector), Microsoft or Mouse Systems Mouse (optional), Roland MPU-401 MIDI Processing Unit, Roland MIF-IPC Interface Card, any MIDI Instruments.

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